Seed Business Management in Africa

John F. MacRobert

CIMMYT.

Seed Business Management in Africa

Seed Business Management in Africa

John F. MacRobert

CIMMYT

The International Maize and Wheat Improvement Center, known by its Spanish acronym, CIMMYT® (www.cimmyt.org), is an international, not-for-profit research and training organization that, together with partners in over 100 developing countries, works to increase food security, improve the productivity and profitability of farming systems, and sustain natural resources in the developing world. · The center's outputs and services include improved maize and wheat varieties and cropping systems, the conservation of maize and wheat genetic resources, and capacity building. CIMMYT belongs to and is funded by the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org), and also receives support from national governments, foundations, development banks, and other public and private agencies.

Correct citation: MacRobert, J.F. 2009. *Seed business management in Africa.* Harare, Zimbabwe, CIMMYT.

ISBN: 978-92-9059-254-9

AGROVOC descriptors: Seed industry, Seed production, Trade, Commodity markets, Marketing

AGRIS category codes: E10, E20, E21, E70, E73, F03

Dewey decimal classification: 338.17

Printed in Nairobi

Contents

List of Tables

List of Figures

Foreword

The past decade has seen a strong growth in the number of new seed enterprises emerging in Africa, Asia and Latin America. If successful, they will contribute tremendously to the economic growth of their countries, regions and farmers. Use of seed of improved varieties encompasses the essence of agricultural productivity improvement and is a major catalyst for investment in organic and inorganic fertilizer, conservation agriculture practices, and labor to provide a greater pay-off to farmers. However, less than 50% of all farmers in low-income countries have access to yield-enhancing maize seed and they are far fewer for other crops. Newly emerging seed enterprises explore new markets, make seed of more diverse varieties and crops available, inform and educate farmers: their success is essential for agricultural economies to succeed.

As a major provider of improved maize and wheat germplasm, available as an international public good, CIMMYT developed this publication as a practical guide for lead personnel of new maize seed businesses. Even though targeted to the African business environment, we expect that its content will benefit newly emerging seed enterprises world-wide. Different from other maize seed production books, it links technical and business related aspects, and most importantly draws on the experiences of entrepreneurs that have succeeded in managing small and large seed businesses under most difficult conditions. We hope and expect that their experience and wisdom, that is greatly acknowledged, will contribute to making a greater number of new seed entrepreneurs more successful. Success in the sense that they see their seed business growing, their investment paying off and improved seed reaching farmers that have so far not benefitted sufficiently from crop improvement and good quality seed.

Nairobi, May 2009

Marianne Bänziger, Director Global Maize Program, CIMMYT

Preface

Seed businesses are a rapidly emerging form of entrepreneurship in Africa. The seed sector in Africa has seen the rise and, at times, demise of national and international seed companies, parastatal seed industries and community-based seed schemes. But there has been a class of entrepreneurs who have maintained and grown seed businesses that have largely been built around maize seed, particularly in those countries where the agricultural sector is vibrant and commercially oriented. In recent years there has been a surge of entrepreneurs entering the seed sector all over Africa, as they have recognized a market opportunity of supplying farmers with quality seed of improved varieties. This has been stimulated by a number of factors such as: the increase in seed distribution schemes by governments and non-governmental organizations, the activities of agencies that have worked at encouraging seed sector development and economic forces that have highlighted opportunities in crop production and hence seed provision. The new seed entrepreneurs range in size, area of operation and seed products, but they may be found in most African states and are characterized by zeal and vision. The question that many consider is how to help these fledgling and growing businesses to become profitable and sustainable. This book aims to contribute to the answer by providing seed entrepreneurs with information on seed business management, particularly as it relates to the maize seed market.

The first chapter of the book examines issues that are key to growing the seed sector in Africa. On the one hand, there are internal factors that seed companies need to ensure are functional, notably, establishing a product portfolio appropriate for the target market, developing a seed grower complement that will produce the seed for the market, and servicing a distribution network to avail seed to the seed buyer. On the other hand, there are external factors that are critical to seed sector development. National seed regulations that facilitate seed company establishment, rapid variety registration and assure seed quality need to be established. The market that seed companies supply in Africa is composed of farmers whose productivity and profitability has traditionally been low. This needs to be changed if certified seed of improved varieties is to become a regular component of farmers' input purchases. Finally, the grain markets for many crops in Africa are under-developed and provide little incentive to farmers to invest in production. If viable output markets are established to create demand for crop products, this in turn will provide incentives for farmers to invest in their crop fields with improved seed, fertilizer and other inputs.

The following chapters are arranged according to a model of business management that first establishes the vision of the company and then formulates and implements strategies in marketing, production and finance to enable the company to move towards the vision. In this book, a vision is considered to be the good which the company intends to achieve through its business activity. Thus, it is outward and forward-looking, while taking into account the internal and external business environments. The three strategic components that support the vision are interlinked and co-dependent, but the first and foremost strategy to formulate is the marketing strategy, for without a market, a company cannot be sustained. Related to the marketing strategy is the development of products suitable for the market. The second strategy discussed is the seed production plan. Since seed scale-up may require multiple seasons, forward planning is required. Furthermore, the success of seed production depends on the environment, contract grower performance and conformity to seed regulations, and hence this strategy is complex but critical to reaching the vision. Once seed of assured quality has been produced, this must be processed into a form suitable for the market. The third strategy of finance brings the marketing and production strategies together and determines the profitability and sustainability of the business.

While a vision and the three strategies are required for business success, the company must be managed on a daily basis to implement plans, evaluate outputs and improve performance. This involves managing people as they carry out their tasks. Hence, the last two chapters of the book deal with human resource and general management. Business managers must provide leadership and effective administration so that the business may be established on integrity, grow in quality product delivery and be profitable and sustainable. Seed entrepreneurs have this passion for success, wealth creation and the common good, and are therefore willing to learn, keen to promote the development of employees, and dedicated to the improvement of their customers, especially the smallholder farmer in Africa. Consequently, this book attempts to provide seed entrepreneurs with information couched in an ethos that will contribute to these noble goals.

John MacRobert
June 2009

Acknowledgements

This book could not have been written without the support and input from many people, who by the grace of God have been part of my life. May I therefore express my sincere thanks and appreciation to the following:
Amy MacRobert, my dear wife and helpmeet
Marianne Bänziger, dedicated mentor and "Mai Chibage"
Barry McCarter, wise and visionary seed entrepreneur
Patrick Devenish, enthusiastic and strategic seed entrepreneur
Munyaradzi Jonga, principled seed production manager
Edgar Rupende, level-headed and forward-looking seed specialist
Ephrame Havazvidi, competent and prolific wheat breeder
Walter Chigodora, passionate and innovative marketer
Nick Goble, motivated and progressive marketer
George Nefdt, enthusiastic personnel manager
Tsungai Gumbo, committed Human Resource practitioner and counselor
Rex Tattersfield, wise and dedicated plant breeder
Peter Freymark, outstanding maize breeding manager
Morgan Nzwere, accomplished and astute financial manager
Chris Maswi, intuitive and proficient financial consultant
Karsten Nielsen, inventive and talented seed conditioning specialist
Adrian Watt, competent instructor and perceptive seed plant manager
Petr Kosina, trainer and communicator
Anne Wangalachi and Judie-Lynn Rabar, supportive and able editors.

Acronyms and Abbreviations

AOSA	Association for Official Seed Analysts
ASARECA	Association of Strengthening Agricultural Research in Eastern and Central Africa
AVRDC	The World Vegetable Center
BEP	Break-even price
BEV	Break-even volume
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
COMESA	Common Market for Eastern and Southern Africa
COGS	Cost of goods sold
CTR	Cash turnover rate
DUS	Distinct, Uniform and Stable
EBIT	Earnings before interest and tax
GM	Gross margin
GMO	Genetically modified organism
GP	Gross profit
GO	Governmental organization
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IITA	International Institute on Tropical Agriculture
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
KPIs	Key performance indicators
MOCB	Minimum operating cash balance
NARS	National agricultural research systems
NGO	Non-governmental organization
NPV	Net present value
OE	Operating expenses
OECD	Organization for Economic Co-operation and Development
OM	Operating margin
OP	Operating profit
OPV	Open-pollinated variety
PBIT	Profit before interest and tax
PBR	Plant Breeders' Rights

PVP	Plant Variety Protection
SADC	Southern African Development Community
SANSOR	South African National Seed Organisation
SWOT	Strengths, Weaknesses, Opportunities and Threats
TO	Turnover
UPOV	Union Internationale pour la Protection des Obtentions Végétales
VCU	Value for Cultivation and Use
WECAMAN	West and Central Africa Maize Network

Introduction

The importance of seed provision for agricultural development cannot be overstated. Apart from environmental factors, access to improved seed and inorganic fertilizers is crucial for determining food and income security of farmers and countries in Africa. Yet, the industries that support the provision of these two inputs are far from meeting the present demand from farmers despite recent growth in agri-business development. With respect to seed supply, the seed sector in Africa is diverse, both in the sophistication of seed enterprises and the seed purchase rates of farmers (Table 1). Within the last decade, Africa has witnessed a four- to five-fold increase in the number of seed companies marketing various types of improved maize seed (Langyintuo et al. 2008). Nevertheless, more than half of the maize area (or 6.7 million ha) is still planted to traditional, unimproved low-yielding varieties. Furthermore, many of the new seed companies are small, producing less than 500 t of seed per annum and marketing this to a minority of localized farmers.

In South Africa, Kenya, Zimbabwe and Zambia, farmers' purchase of certified seed of improved varieties is above 70% of the maize area planted, while in most other countries less than 30% of the maize area is sown to certified seed (Langyintuo et al. 2008). Farmers indicate that lack of cash or credit, long distance to retailers, unpredictable and unattractive grain prices (particularly immediately after harvest), and lack of information on variety performance and seed availability are the main disincentives to use improved seed. However, at the base of this is the lack of certified seed of improved, adapted and appropriate varieties available in the market place. If this seed was accessible close to farm homesteads and at reasonable prices relative to the grain price, it is expected that smallholder farmers would purchase and benefit. This has been amply demonstrated in countries such as Zimbabwe, Kenya and Zambia, where maize hybrid seed purchase rates by smallholder farmers have been consistently high in the past two decades. Therefore, it is generally accepted that a more diverse, geographically dispersed and competent seed sector is crucial to achieving the goal of increasing farmer adoption of improved seed across Africa.

Table 1 Estimated maize seed demand and supply in selected countries in eastern and southern Africa.

Country	No. of seed companies interviewed	Seed sales (x1000 t)		Maize area	Seed demand	Adoption Rate
		OPV	Hybrids	(x 106 ha)	(x103 t)	(%)
Ethiopia	13	2	6.2	1.7	42.4	19
Kenya	13	1.7	26.3	1.6	38.9	72
Tanzania	15	3.9	7.3	2.6	64	18
Uganda	8	3.5	2.2	0.7	16.5	35
Angola	5	0.8	0.2	0.8	19.3	5
Malawi	10	5.4	2.5	1.4	35.3	22
Mozambique	16	3.1	0.2	1.2	30.3	11
Zambia	11	0.5	9.7	0.6	14.1	73
Zimbabwe	16	2.2	25.9	1.4	34.4	80
Total	**107**	**23.1**	**80.5**	**12**	**295.1**	**35***

* This is an average figure.

Source: Langyintuo et al. (2008).

The informal seed sector and seed supply schemes of government and non-governmental organizations (NGO) continue to play a role, particularly in those countries where the formal seed sector is poorly developed. Recent estimates indicate that 66%–85% of seed used by resource-poor farmers in sub-Saharan Africa is derived from informal markets (Monyo et al. 2004; Tripp 2001). In some instances, the NGO seed sector purchases seed from established seed companies and makes it available at subsidized prices or free-of-charge to farmers that do not have access to the formal seed sector due to inaccessibility or poverty. Where NGOs are involved in seed development schemes, local farmers are organized into seed production and marketing cooperatives that produce small quantities of seed for local distribution. Even in a country like South Africa, where the formal seed sector is highly sophisticated, smallholder farmers may be sidelined, and so informal seed systems and community-based seed schemes are a significant source of seed for such farmers. These community-based seed schemes face many of the sustainability issues similar to those of formal seed companies.

Consequently, the strengthening of these schemes through the application of sound business management principles is necessary for their growth and sustainability.

Although the African seed sector does not currently appear to be particularly strong, there are many signs that this is changing. The demand for locally produced food, feed and fibre is increasing in Africa due to population increase and urbanization. Recent surges in commodity prices and world economic downturns have highlighted the necessity for self-reliance amongst nations. Hence, the need for greater agricultural productivity on the continent is clear. Consequently, governments are recognizing the need to further stimulate the agricultural sector; farmers are seeing more opportunities for marketing their products; small agro-input companies are emerging; while existing large seed companies are exploring new markets in many countries. In addition, donor agencies, international organizations and NGOs are becoming more commercially oriented in their development assistance. The opportunity this poses for seed companies, and other agricultural input-supply and output industries, is tremendous.

Seed business management differs from many other manufacturing or retailing businesses. While seed businesses have the same basic goal as other businesses, viz., the making of sustainable profits through meeting customer needs, there are many differences in their business organizations, product cycles, marketing strategies and financial management. Field crop seed businesses are faced with a long production lead-time (up to four years in the case of certain hybrids), a concentrated seasonal selling period, and a product line that is perishable, subject to strict regulatory production and quality systems and vulnerable to environmental stresses. In addition, the development and registration of new products is often a long process, while customers are diverse, decentralized, and have a wide range of product requirements related to the highly variable socio-economic and biophysical environment of Africa. Consequently, seed business managers need to have particular skills in issues such as long-term cash flow and inventory management; seed production; processing and quality assurance; market knowledge application; and product evaluation and development.

The internal components of a seed business are also unique, beginning with variety development and ending with the sale of seed to customers or farmers (Figure 1). Each of the stages in the process is essential and related to the others, but a seed business need not be directly involved in each component of the chain. A business may concentrate on a particular link or a subset of the chain, and sub-contract the other components to other companies or organizations. In many cases, small seed businesses are simply involved in the marketing and sale of seed procured from other

> A seed business is any person [or group] who is willing to produce and market certified [quality] seed under their own responsibility.
> *(Dr. Joe Cortes)*

organizations. In such a case, the products (seed of varieties) may be derived from a National Research Program, a Foundation Seed Company or a CGIAR center, while the production may be carried out by contracted farmers, who may also process and package the seed into the company's bags. Alternatively, a seed business may simply purchase seed from other companies and sell this directly to farmers, in which case they are acting more like an agent or retailer than a seed company in the broad sense of the term. Regardless of how a seed business is structured or how much of the seed chain the business is directly involved in, long-term success requires that the whole chain is operated effectively and is well managed to ensure that quality seed of improved, adapted and appropriate varieties is available for sale to farmers.

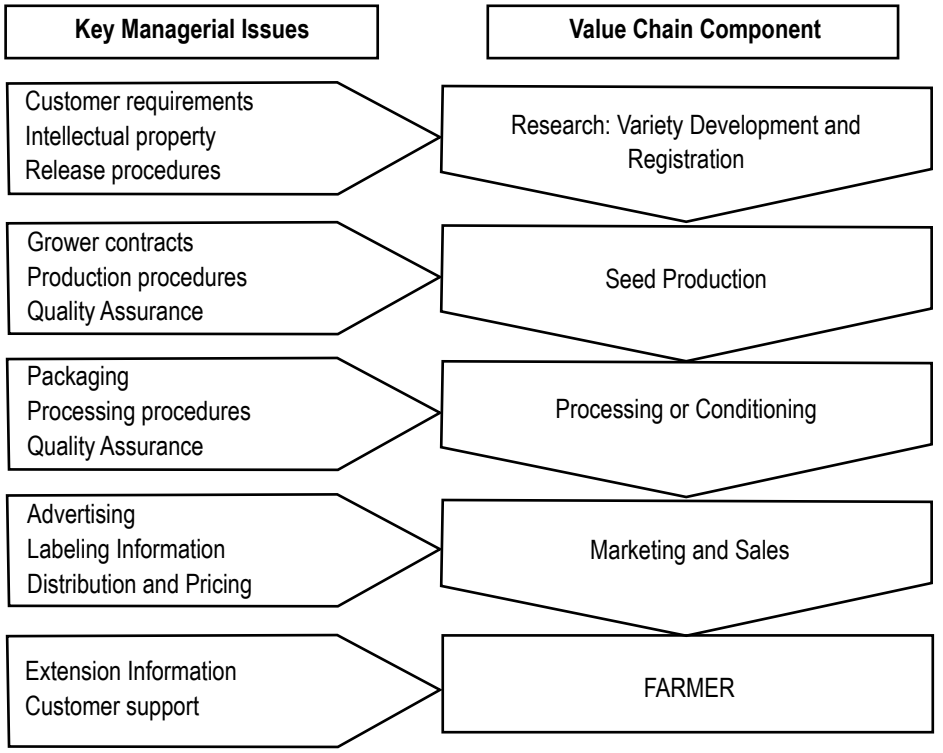


Figure 1 The basic components of the seed value chain and the related key managerial issues.

The question then, is: "How does one make such a unique business successful?" The answer is obviously not a simple one, nor is seed business management something that may be learned by merely reading a book such as this. Seed businesses are highly dynamic and demanding, requiring long-term commitment, involvement, fortitude and resilience. The contents of this book only provide some insights and ideas for seed business managers. It is the application of these precepts and principles to the individual business in the context of the economy as a whole, drawing on the experience of the

managers and employees from within and without the business, and observing, learning and applying the daily lessons from the "shop floor" that will make a difference.

This book is based on a simple business model whereby the overall goal or vision of the business is defined and supported by the three main strategies of marketing, production and finance. These strategies are developed within the context of the business environment, and serve to guide the real-time activities of the company. Since the seed business is dynamic, the goals and strategies of the business must likewise be dynamic. Thus, continual analysis of progress, evaluation of activities, and estimation of external factors must provide managers with information to mold, to move and improve business processes. Furthermore, since businesses are not inert objects but made up of people, seed business managers cannot neglect human resource management.

The long-term nature of the seed business requires careful planning of the three strategic components of the business, namely, marketing, production and finance. Planning the marketing strategy is related to matching the customer with an appropriate product. Managers need to ask who their customers are, what their requirements are and how they can get the required product to the customer in a form and at a price that will encourage the customer to buy his product rather than a competitor's. Customers will generally buy the products that they want, and for seed, this means providing seed of varieties that are adapted to the farmer's environment and management style, suitable for the farmer's needs, of a reliable quality, in the required pack size, at an affordable price and at a convenient location. Developing this marketing strategy therefore requires an intimate knowledge both of the customer and the varieties available, so as to bring them together to effect the sale. This may mean taking what the company already has in the way of varieties to the place where they are required, or the development or acquisition of varieties that customers need.

Having defined the marketing strategy, the seed business manager is in a position to develop a production strategy. It is only sensible to produce what the customer requires, in terms of variety, quantity and quality. The production strategy therefore defines the plan of how to produce the seeds to be sold. Seed production usually involves a number of steps, from breeders' seed through basic seed to certified seed, which will take a minimum of three seasons, if the three steps are followed. In addition, there are issues of seed growers, regulations, processing and packaging to be dealt with. This therefore requires careful forward planning of the following areas:

- Determining the amount of certified, basic and breeders' seed needed to be produced to meet the future sales goals;

- Contracting and supervising seed growers to grow the different classes of seed;
- Processing the seed into a saleable form, including cleaning, grading, dressing and packaging;
- Conforming the production process to the government seed regulations and internal quality assurance measures; and
- Managing and maintaining machinery and equipment to ensure timely supply of quality seed.

Finally, the marketing and production strategies both have financial implications which have to be formulated into a strategic financial plan. The financial strategy therefore brings the marketing and production strategies together in income and expense budgets to see if the plan is profitable. However, profitability *per se* is insufficient to define business success, as cash flow is equally critical, especially for sustainability. A business may be profitable but have a negative cash flow due to poor cyclical cash management, by having too much unredeemed credit, or both. The financial strategy therefore analyses how the marketing and production strategies should be modified in order to achieve profitability and positive cash flow. Therefore, the financial strategy works out schemes on how to finance production and marketing, and develops methods of monitoring and evaluation to keep the company in good real-time financial health.

The three strategies of marketing, production and finance are thoroughly integrated and so the planning process is not linear but iterative and dynamic. The manager needs to balance all three strategies within the framework of the resource limitations and personnel capacity, while accommodating and making the most of the prevailing external socio-economic environment. Plans are not static, but need to be flexible and adjustable. Neither are they of any value unless implemented with purpose, passion and perseverance.

This description of the unique nature of the seed business and the presentation of some key factors needed to make it a success illustrate that the seed business is not for the entrepreneur who wants to make a quick and easy profit. This is a long-term business with many demands and numerous pitfalls. Nevertheless, it is possible to succeed through knowing, planning and managing the business. Farmers in Africa need courageous and committed seed companies so that the gains from public and private breeding efforts are made available for increased and sustainable agricultural production. This book is presented as a resource to seed business entrepreneurs who seek to make a difference to the livelihoods of crop farmers in Africa.

1

Growing the Seed Industry in Africa

Purchase of improved seed by farmers in Africa, other than in a small number of countries, is infrequent. Based on a survey of seed sales in 2007, estimated adoption rates ranged from 5% in Angola to 80% in Zimbabwe (Langyintuo et al. 2008). Compared with the adoption rates observed by Hassan et al. (2001) in 1997, a decline was noted in Angola, Zambia and Zimbabwe but there was an increase in six other countries (Figure 1.1). Since the use of improved seed is at such a low level in most countries, there is the apparent potential to grow the seed industry in Africa.

Entrepreneurs seeking to establish or grow a seed business in markets with low seed purchasing frequencies are faced with a number of challenges over which they may have direct influence. These include the acquisition and maintenance of a portfolio of improved, adapted and appropriate varieties, the development and management of a reliable seed grower base, and the establishment a distribution network. This does not minimize the importance of finance or other managerial issues, but recognizes that without products, production and marketing, there is little, if any, prospect of growth. Furthermore, the external environment of the business will have a significant influence on the possibility and potential for growth. Issues such as government seed and agricultural policies, agricultural productivity and macro-economic circumstances may pose serious challenges to existing and emerging seed businesses. There may be little that individual seed businesses can do directly to significantly influence and improve these external conditions for seed sector development. However, through lobbying, strategizing and adapting to these circumstances, growth may still be possible.

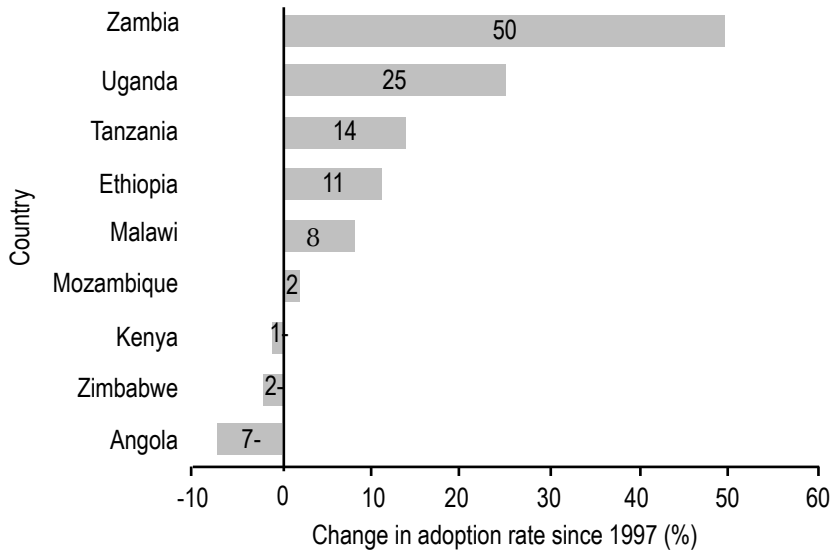


Figure 1.1 Changes in adoption rates of improved maize varieties from 1997 to 2007.

Source: Langyintuo et al. (2008).

Controllable factors critical for success of a seed business include products, production and marketing

Seed companies have the ability to formulate their structure and function to optimize their own performance, while also contributing to the growth of the seed industry as a whole. Factors within the business that may hinder or promote seed sector development are therefore of prime concern. Although it may be possible to enumerate a multitude of factors, there are three that stand out as critical, viz., the product portfolio, the seed grower capacity and the distribution network.

Ensure a product portfolio appropriate for farmers

Whether a seed company is developing a business in an established or emerging market, a key component of market development is the crop and variety portfolio. Most large seed companies have their own variety development programs, but for small companies, this poses a significant challenge due to the cost and long-term nature of crop breeding. Consequently, organizations that provide improved, adapted and appropriate varieties, either as public goods or on licence agreements, are essential to seed market development. Varieties must not only be improved over what exists, but must be adapted to the environments of the target farmers and be appropriate to their requirements, while also meeting the market requirements of the maize industry.

Within sub-Saharan Africa, CIMMYT, the International Institute on Tropical Agriculture (IITA) and national agricultural research systems (NARS) provide public maize germplasm to seed companies. Similarly, legume, sorghum, millet, rice and vegetable varieties are available from institutions such as the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT), The World Vegetable Center (AVRDC), the International Rice Research Institute (IRRI) and NARS. In the case of public germplasm from the CGIAR, this may be accessed in several ways[1], either directly as finished products, or as source germplasm for proprietary breeding programs. The latter use usually results in more diverse and larger numbers of elite varieties becoming available, but typically only happens in countries with strong NARS breeding programs and within larger seed companies. In the case of direct variety releases of public germplasm, seed companies either test and apply for release of varieties on their own, or engage in seed production and marketing of varieties registered by NARS, on some formal or informal basis.

Over the past five years to 2008, rights to release over 100 CIMMYT hybrids and open-pollinated varieties (OPVs) have been given to NARS and seed companies in Africa. In southern Africa, from 2005 to 2008, over 90 new maize varieties were registered annually (Table 1.1). The majority of these were registered in South Africa, with most being hybrids. Even excluding South Africa, the number of hybrids released was almost twice that of OPVs. Although seed companies registered a total of 18 OPVs in the four years, NARS registered 35 OPVs, indicating their interest in supporting smallholder farmer seed security.

[1]Since January 2007, all CGIAR germplasm transfers are subject to the Standard Material Transfer Agreement (http://www.cimmyt.org/english/wps/obtain_seed/smtainformation-en.htm) of the International Treaty on Plant Genetic Resources (ftp://ftp.fao.org/ag/cgrfa/it/ITPGRe.pdf).

Table 1.1 The number of maize varieties registered with National Seeds Authorities in the Southern African Development Community (SADC).†

	2005				2006				2007				2008			
Country	Private		NARS		Private		NARS		Private		NARS		Private		NARS	
	H	O	H	O	H	O	H	O	H	O	H	O	H	O	H	O
Angola								2								6
D.R.Congo																2
Lesotho								3								
Malawi				1				1			2	1	6		1	2
Mozambique											2					
S. Africa	70	3		4	58	5		3	58			2	72			
Swaziland	2	2			2			2					2			1
Tanzania					1	2			3		1	1		1		1
Zambia	5	2			13				17				16			3
Zimbabwe		2	1		6	1	1		6				5			
Total	**77**	**9**	**1**	**5**	**80**	**8**	**1**	**11**	**84**	**0**	**5**	**4**	**101**	**1**	**1**	**15**

Note: H = Hybrids and O = OPVs. These figures are from 2005 through 2008 by private sector seed companies and National Agricultural Research Systems (NARS).

† This does not represent the number of varieties on the market, but only new varieties registered with National Seeds Authorities in each year.

Source: NSIMA Annual Report 2008, CIMMYT Harare

The great number of varieties registered in South Africa is an indication of the dynamic nature of that seed industry. But the question may be asked whether this is sensible or not. When examining the variety registration situation in South Africa, two points may be noted. First, the South African seed sector is highly sophisticated, with numerous seed companies, most of which have proprietary breeding programs, and sell seed (both normal and genetically modified [GM], and white- and yellow-grained varieties), to demanding and discerning large-scale farmers growing maize in a diverse range of mega-environments. Second, the number of varieties registered each year is accompanied with a significant number of variety withdrawals from the registration lists (Table 1.2). In 2008 there were 441 maize varieties on the South African National Variety List maintained by the South African National Seed Organisation (SANSOR), but only 25% were listed for seven years or more, while 40% were listed for two years or less, and 35% for between three and six years (E. Goldschagg, personal communication, SANSOR 2009). Of the varieties deleted from the list in 2007, 27.5% were listed for seven years or more, 25% for two years or less and 47.5% for between three and six years. Almost half of the varieties (52%) were listed for only two to three years. Thus,

there is a rapid turnover of varieties in South Africa, with most varieties having a short lifespan of two to three years. Only those that are exceptional performers, both in terms of farmer and grain industry acceptability, and seed company profitability, remain on the market for longer than three years.

These data from South Africa suggest that as the seed sector grows and becomes more competitive, variety life-cycle decreases. This is accompanied with the need for farmers to be more aware of changes and advances in variety characteristics and availability. Newer varieties are expected to be higher performing and more suited to particular environments than older varieties. Therefore, farmers need to be able to choose appropriate varieties from a wide range of options. From a seed company's perspective, farmer education and service provision is required to gain and maintain sales, since not only is there a wide range of variety choice from competitors, but there are also intra-company variety dynamics which have to be conveyed to farmers. Thus, it is not uncommon in South African to find maize farming areas dotted with many road-side demonstrations, variety signage on prominent fields, and many glossy variety promotion brochures. Lessons may be learned from this for the extension of improved varieties into other countries in Africa, even where seed purchase frequencies are low. The more farmers hear of and become familiar with new varieties, the more likely they are to purchase seed of the improved varieties.

Table 1.2 The number and age of maize varieties currently on the South African list of varieties.

Duration on National	Currently on list		Deleted 2008	
Variety List	Number	%	Number	%
7 years or more	111	25	24	28
6 years	48	11	5	6
5 years	30	7	3	3
4 years	48	11	9	10
3 years	28	6	24	28
2 years	42	10	21	24
1 year	62	14	1	1
Less than 1 year	72	16	0	0
Total	**441**	**100**	**87**	**100**

Source: Data provided by E. Goldschagg of SANSOR, South Africa, 2009.

Given the great diversity of maize growing environments and consumer preferences in Africa and the significant need for a much greater number of seed enterprises, the strengthening of national public sector breeding programs is a positive and necessary

development which should enable emerging seed companies to access and market a greater number of locally adapted varieties without the need of managing a costly variety development program.

Box 1.1 Entrepreneurial considerations for choice of seed growers

- Large farm to enable required isolation distances
- Large field size (5–20 ha)
- High and reliable seed yields
- Capable crop management with adequate labour
- Opportunities for irrigation
- Proximity to good roads and seed processing facilities

Rationale

- Reduced training costs
- More consistent seed quality
- Reduced transport costs
- Reduced costs and time for seed inspection; crucial if seed inspection is done by a limited number of government officials
- Fewer contractual agreements
- Lower risk of contamination
- Lower seed production cost
- Lower seed price

Develop and maintain a productive seed-grower base

Maize seed production requires competent seed growers who can meet the isolation requirements and production standards for seed certification, and achieve the yield expectations of seed companies (see Box 1.1). In many parts of Africa, this is a major challenge to seed companies because most farmers are farming on smallholdings in close proximity to one another. From an agronomic perspective, seed production is essentially similar to normal crop production, particularly with self-pollinated crops and OPVs, but it does require greater attention to detail, more labor and sufficient isolation. Consequently, optimum field sizes for quality seed production are considered to be five to 20 ha, particularly for hybrid production. Very small fields (<5 ha) are prone to greater risks from foreign-pollen contamination, and therefore isolation becomes a particularly important factor with small-scale farmers growing cross-pollinated crops. For a seed company, numerous small fields of seed pose greater logistical challenges than fewer large fields.

There have been a few cases of successful maize OPV seed production with smallholder growers, in which communities of farmers have been contracted to grow a particular variety (Mkhari et al. 2006). This helps to overcome isolation risks, but it does require community cooperation and integrity.

However, there has not been much progress in successful community maize hybrid seed production in Africa, although this is currently being attempted in Ethiopia. In principle, communities that have produced maize OPV seed should also be able to produce hybrid seed, provided that the farmers are educated in the requirements and skills needed. In particular, hybrid seed production requires differential planting of male

and female parents, complete and timely removal of female tassels, removal of male plants following pollination, selection of cobs at harvest, and avoidance of admixtures of seed during shelling. This process takes considerable management of time and labor, and thus farmer education along with supervision is critical for successful community hybrid seed production.

Seed companies in Africa are therefore faced with the logistical challenges of smallholder seed production. Concurrent with this is the issue of formulating and implementing contractual arrangements with smallholder farmers, especially in a community setting. There have been many efforts to develop contract farming systems with smallholder farmers with various agricultural commodities, and seed companies may find successful models to follow (Kirsten and Sartorius 2002). Seed pricing is a particularly important component of seed production, and with crops that have a very low seed:grain price ratio, such as beans, groundnuts, sorghum and wheat, it may be difficult to secure seed deliveries from farmers. Consequently, contracts, trust and timely payments must be established to enable growth of the seed business.

Establish a distribution network for marketing products

Farmers in Africa are widely dispersed and often distant from the towns or cities where seed companies are located. Furthermore, since most farmers grow small areas of crops and therefore buy small quantities of seed, no individual farmer or group of farmers accounts for a significant proportion of a seed company's sales (Krull et al. 1998). The high transaction costs related to numerous small sales makes seed companies reluctant to sell directly to end-users. Consequently, seed marketing systems are often characterized by intermediaries and minimal distribution beyond commercial centers. This lack of close access to seed retail points has been cited as a major limitation to farmers adopting improved varieties (de Meyer, n.d.). Seed companies face a difficulty in economically distributing their product to places that are convenient for farmers to access. For example, it is estimated that

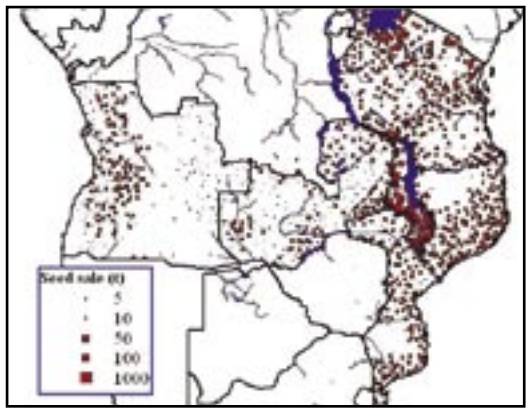


Figure 1.2 The distribution of retail outlets required to sell 1 t of maize seed to 35% of farmers within a radius of 30 km of each outlet in five southern African countries.

Source: Map produced by D. Hodson, personal communication, CIMMYT 2005.

in Angola, Zambia, Mozambique and Tanzania, over 1,700 retail outlets would be required in order to sell 1 ton of maize seed to 35% of farmers within a 30 km radius of each outlet (Figure 1.2).

The principal factors that hinder the establishment of a dispersed distribution network are the poor transport infrastructure in rural areas, the high transaction costs of dealing with many small distributors, and problems of establishing reliable credit systems with rural traders. Some seed companies have tried to overcome this by positioning "wholesale" outlets in strategic rural centers, where small retailers from neighboring districts may purchase seed stocks with cash. Other strategies have included encouraging farmers to form buying groups, the appointment of farmers as rural consignment stockists, mobile seed shops, and promotional activities to entice farmers to travel to rural centers to purchase seed. Rural seed fairs have also been attempted as a means of encouraging the informal seed trade to flourish alongside the formal trade, especially for legumes and crops other than maize which may be less attractive to a seed business. There remains, however, a great need for further innovative thinking to improve the distribution of seed stocks in rural Africa to encourage growth of the seed sector.

External factors influencing seed sector development

Seed companies obviously exist within the context of the agricultural and socio-economic environment of the country or region where they are located. It is necessary, therefore to understand these external factors and seek ways to influence them for the enhancement of seed sector development. In principle, three essential aspects that need attention are national seed regulations, farmer productivity and the grain industry.

National seed regulations set seed quality standards and market possibilities
The status of seed regulations and their implementation in Africa shows significant diversity amongst countries (Table 1.3). Although Tripp (2001) recognized the necessity of seed regulation to ensure quality, he observed that strict government regulation may act as a disincentive for the emergence of a commercial seed sector. At the time of his publication, a minority of countries in Africa had comprehensive legislation aimed at facilitating the development of the seed sector.

Although most countries have systems for variety registration, these are often time-consuming and costly. Since there is currently no functioning regional variety registration system in either western, southern or east Africa, each new variety must be registered in each country, despite the fact that crop mega-environments cross national

boundaries. Consequently, widely-adapted improved varieties take many years to be registered in countries with similar production environments and systems. This hinders seed provision and farmer productivity.

Few countries in Africa have any form of plant variety protection (PVP) legislation. Some seed entrepreneurs view this as a major obstacle to expanding business interests for fear of losing control of genetic resources. This is particularly the case with self-pollinated crops and hybrid maize seed production. Seed certification standards are not equivalent in all countries in Africa, and only a few countries have International Seed Testing Association (ISTA) accreditation, which often impedes seed trade amongst nations. Thus, much effort has been made in recent years to harmonize seed regulations amongst economic blocs and research associations (e.g., WECAMAN, SADC, COMESA and ASARECA). Although agreements have been reached at the technical level on regionalized seed regulations, phytosanitary procedures and variety registration, these are yet to be formalized in national legislation and implemented at the administration level.

Table 1.3 Current status of Seed Control Legislation in southern Africa.†

Seed Control Regulation	AO	BW	CD	LS	MW	MZ	NA	SZ	TZ	ZA	ZM	ZW
Seeds Act	Y	N	Y	N	Y	Y	N	Y	Y	Y	Y	Y
Plant Variety Protection	N	N	N	N	N	Y	N	N	Y	Y	Y	Y
Variety Registration	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y
ISTA Accreditation	N	N	N	N	Y	N	N	N	N	Y	Y	Y

Note: Y indicates that the relevant legislation exists, while N indicates that the legislation was absent at time of publication

†AO – Angola; BW – Botswana; CD – Congo DRC; LS – Lesotho; MW – Malawi; MZ – Mozambique; NA – Namibia; SZ – Swaziland; TZ – Tanzania; ZA – South Africa; ZM – Zambia; ZW – Zimbabwe.

Source: P. Setimela, personal communication, 2008 (unpublished data).

Farm productivity influences seed demand

Yields of crops in Africa are generally low due to various biotic, abiotic and managerial constraints. For example, national average maize yields range between 0.5 and 1.5 t/ha in many southern African countries, where fertilizer use on arable land is, on average, 0.009 t/ha. (FAO 2003). Consequently, the cost of seed may represent a significant proportion of the value of the grain harvest, depending on the crop yield and the seed to grain price ratio (Figure 1.3). The purchase of seed is only justified where yield levels are high or the seed:grain price ratio is low (Heisey et al. 1998). Pixley and Bänziger (2004), in an economic evaluation of hybrid and OPV seed use, concluded that improved OPV

seed in preference to hybrid seed was justified where yield levels are low (e.g. below 1.5 t/ha) and hybrid seed and fertilizer prices are high relative to the price of grain. The use of improved OPVs was also particularly advantageous if the money saved by using OPV instead of hybrid seed was used to purchase additional inputs such as fertilizer, herbicide or hiring additional labor. Consequently, an increase in farmer productivity is likely to favor the development of the seed sector.

Seed companies may adopt a number of strategies to stimulate seed sales through increasing farmer productivity. The provision of improved varieties is at the root of improving farmer productivity, but this needs to be complemented with improved agronomic practices. Indeed, improved agronomic management may have a higher productivity pay-off than improved seeds per se (MacMillan et al. 1991). Consequently, variety demonstration and promotion activities should be coupled with extension information that promote improved agronomic practices, such as conservation agriculture, use of manure and fertilizer, timely planting, weed control and pest management.

Interventions which reduce farm-gate seed price relative to grain price may encourage farmers to purchase seed. These include further liberalization of seed regulations, support to more competitive markets (e.g., training and credit opportunities to agro-dealers), and infrastructure investments. In addition, seed companies may implement strategies to foster improved farmer productivity by providing crop management information on seed packaging and offering agronomic advisory services to seed purchasers. However, the importance of raising farmer productivity is a national concern, and seed companies can only contribute a small proportion of the total effort needed. National agricultural extension services, provision of information and the development of the fertilizer and crop chemical sector are equally important if the seed sector is to grow.

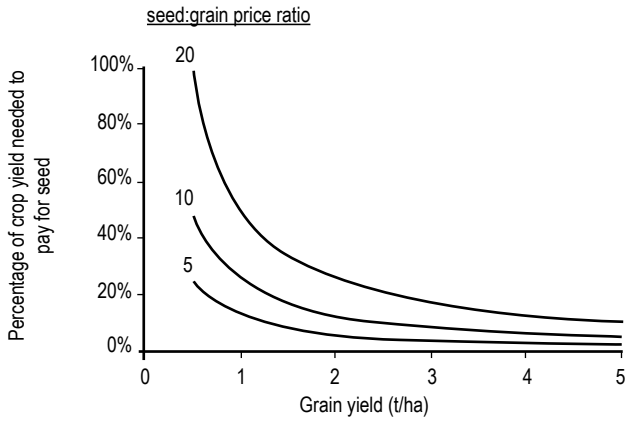


Figure 1.3 The proportion of the grain harvest required to cover the cost of the seed as a function of yield and the seed:grain price ratio, assuming a seed rate of 0.025 t/ha.

Functioning grain markets and value-added industries underpin seed market growth
Functioning grain markets or value-adding grain-based industries act as a stimulant to crop production (Jayne et al. 1997). Generally, grain markets are poorly developed in Africa, such that on a local scale, price fluctuations are highly influenced by available grain stocks. Furthermore, there are few crop-based industries, other than local millers and small oil expressers, in rural areas of Africa. Hence, it is normal for farmers to be faced with low grain prices during and following harvest. This may serve as a disincentive to produce crops beyond that required for domestic use. Furthermore, seed companies will rarely consider entering a locale if there is no grain market that will absorb the additional maize production without significantly depressing grain prices (P. Devenish, personal communication, 2007). Few seed companies are prepared to also become grain brokers, thus the development of the seed sector is constrained by the lack of vibrant grain markets.

A number of novel approaches have been advanced to improve the grain market stability in Africa. These include agricultural commodity exchanges, community grain banks, inventory credit programs and the development of on-farm storage facilities (Langyintuo 2005). Where these have been implemented (e.g. in Kenya and Ghana) there has been a measure of success in market stabilization and consequent stimulation of improved seed demand. On a national scale, support prices and single-channel market systems have been implemented with varying success, but these approaches generally function to reduce free grain trading and grain-based industry development. Greater utilization of maize grain in livestock enterprises and industrial processes, such as ethanol, starch, oil and food processing, may serve to greatly stimulate maize production and hence the seed sector.

Summary by way of the seed value chain

Seed sector growth in Africa is not a simple process but a complex of interacting and co-regulating processes. There are many actors, supporters and influencers that will determine how fast and how large the seed sector grows. This may be summarized by examining the seed value chain of the seed industry (Table 1.4). In a generic form, the seed value chain begins with the development of improved varieties. This is a lengthy and costly process, usually carried out by NARS, CGIAR and some large seed companies. The major bottlenecks that exist are high staff turnover in NARS breeding programs, poor infrastructure on research stations, inadequate funding for long-term crop breeding activity and lack of appropriate germplasm for certain crops and environmental stresses. Nevertheless, opportunities exist for linking public and private breeding efforts in order

to make more germplasm available and to incorporate new breeding tools, such as marker-assisted-selection and the double-haploid technique, into national and private breeding programs. The need for continual supply of improved germplasm cannot be over-estimated because crops are repeatedly exposed to changing disease and pest pressures, while global climate uncertainty poses threats that can best be mitigated by varieties that are tolerant of expected abiotic stresses.

Germplasm development is usually carried out on research stations and managed-stress environments, but breeding progress is also related to how well the varieties perform in the target environment of the farmers' fields. Thus, variety testing plays an important role in identifying superior products. Farmer participation in variety testing improves the ability of breeders to select products that are improved over existing varieties, while also indicating adaptability to the target environment and which entries meet the farmer's preferences. Testing of improved varieties leads into variety registration, but this is where a bottleneck is often encountered. As has been shown from the case of South Africa, regulated but non-lengthy variety registration is a component of a vibrant seed industry. Facilitating variety release in Africa will make a significant contribution to seed sector growth.

However, registered varieties must be produced and marketed, and it is perhaps these components of the seed value chain that need the most attention and innovation. Farmer capacity to produce seed, especially of hybrid maize, in most African countries is seriously deficient because of small farm sizes, lack of resources and insufficient irrigation facilities. Nevertheless, opportunities exist to strengthen and link farmers with seed companies for contract seed production and for the provision of training and inputs for increasing production capacity. At the processing stage of seed production, equipment is often inadequate or non-existent in small companies, but this may be overcome through contract processing or investments into either community or farmer-based processing plants. Throughout the production and conditioning process, quality assurance is essential to ensure that seed of acceptable quality is placed on the market.

Marketing seed in Africa requires an excellent and extensive distribution network, appropriately sized seed packs and a seed price that relates equitably with grain prices and productivity. Government policies on rural development, farm credit, input and output pricing and grain marketing will influence a seed company's ability to market seed profitably. Nevertheless, promotion of products, provision of information to farmers and retailers, and informed response to customer needs will assist in securing seed sales.

Finally, the growth to the seed industry cannot be conceived separate from a concomitant growth in the whole agricultural economy of Africa. Seed alone is not the silver key that will unlock farmers' productivity or national economies, but it is one of several keys that need to be used to unlock the many doors and gates that hinder agricultural development and economic enlargement. Since the private sector will play a crucial role in the seed sector, seed business management enhancement must be viewed as a skill that will polish the key of seed.

Table 1.4 A generic seed value chain that identifies the value chain actors, supporters, influencers and the associated bottlenecks and opportunities.

Stage	Value Chain Actors	Value Chain Supporters	Value Chain Influencers	Bottlenecks	Opportunities
Variety development	• NARS • Seed companies • CGIAR • Universities	• Government • Private sector • Donors • NGOs	• Farmers • Grain merchants and processors	• High staff turnover in NARS breeding programs • Poor infrastructure • Low funding; low salaries • Lack of appropriate germplasm	• Strengthen collaboration and Germplasm exchange amongst CGIAR-NARS-Seed companies • New breeding tools and techniques
Variety Testing	• NARS • CGIAR • Seed companies • Universities • NGOs	• Government • Farmers • Extension Services	• Seed authorities • Farmers	• Poor infrastructure and equipment for abiotic and biotic stress screening • Imprecise and inaccurate data recording leading to invalid trials • Slow analysis and presentation of data • Inappropriate site selection • Lack of farmer-participation in variety selection	• New statistical tools and techniques • Mother-baby Trials and Regional Trials • National Variety Trials • Training staff of NARS, Seed Companies and NGOs in trial management and analysis
Registration of Varieties	• NARS • Seed authorities • Seed companies	• CGIAR • Government	• Farmers • NGOs • Grain merchants and processors	• Lack of registration procedures in some countries • Lack of breeders rights legislation • High cost and lengthy time needed to register varieties	• Harmonization of seed trade policies and regulations • Regional variety release • Continent-wide variety lists

Table 1.4 A generic seed value chain that identifies the value chain actors, supporters, influencers and the associated bottlenecks and opportunities (continued).

Stage	Value Chain Actors	Value Chain Supporters	Value Chain Influencers	Bottlenecks	Opportunities
Seed production, processing and quality assurance	• NARS • Seed companies • CBOs • Farmers • Seed authorities • NGOs	• CGIAR • Extension services • Agro-input dealers • Credit suppliers	• Government • Grain merchants and processors • Farmer Unions	• Inadequate breeders' and basic seed • Farmers' low capacity to produce seed due to small farm size and lack of resources • Insufficient irrigation facilities • Lack of seed processing equipment • Poor packaging materials • Poor storage facilities	• Revolving fund for breeders' and basic seed production • Strengthen and link CBOs with seed companies for contract seed production • Private-public partnerships • Contract seed processing with existing seed companies • Community and/or farm-based seed processing plants • Training of seed producers
Marketing and distribution	• Seed companies • CBOs • Retailers/ Traders/ Stockists • Government • NGOs • Media • Grain merchants	• Seed companies • Government • Credit suppliers • Transporters	• Farmers • Government • NGO's	• Long distances to retail outlets • Ineffective promotion • Inadequate awareness amongst farmers of improved varieties • Restricted distribution networks in outlying areas • Poor storage facilities • Poor road infrastructure in rural areas • Lack of knowledge amongst retailers of seed marketing	• Link seed companies with retailers • Regionalize seed trade • Improve marketing and distribution channels through infrastructure development • Promotional materials of improved varieties published and distributed through all media types • Field demonstrations and farmers' days • Retailers become seed agents

2

Vision, Strategy and Tactics

There are no boundaries in business, except those that are defined by the business itself within the context of the ethical and legal frameworks that exist. Consequently, the owners or managers of a business are free to define the scope, products, geographic location, corporate governance, business model and all other components of their business. Whether a seed company decides to cover the entire seed value chain or only certain components is entirely the decision of management. Similarly, whether a seed company wishes to market seed of maize, legumes, or a multitude of crops, is open to choice. However, boundaries must be set; otherwise managers will never know what, where or how it should be doing business, at least in a methodical and planned manner. Thus, in order to set business boundaries, or establish a framework within which the business will function, the managers need to define the vision of the company, and prepare strategic plans to make the vision a reality.

Vision, strategy and tactics

In the management of a business there are three basic components—first, establishing a vision for the company; second, determining strategic plans that are expected move the company towards fulfilling the vision; and three, implementing tactical decisions on a day-to-day basis to move the company towards the vision.

A vision is a statement of what the company intends to achieve in the long term. This sets the future focus of the organization and acts as a guide for all the company's activities. Without a vision, a company will flounder. Although many business owners or managers have a vision for their company, this may not be clearly formulated or communicated to the employees, resulting in a measure of aimlessness in staff activity. Therefore, to have a clear direction, coordinated activity and motivated staff, every business must establish and communicate its vision.

Strategic planning is a management tool for organizing the present on the basis of projections of the desired future. In other words, strategic planning is founded upon the vision of the company, considers internal and external circumstances, and arranges business structure and modes of operation in a manner that will most likely enable the business to realise the vision. The strategic plan will also define the targets and measures that will be used to analyze progress towards the vision. In the case of seed business management, three strategic pillars are recognized as supporting the vision: the marketing strategy, the production strategy and the financial strategy; which together form the mission, or the way the business will be formulated and managed to support and reach towards the vision.

Tactical management is concerned with the real-time and on-going decisions and actions that move the company along the road towards the vision according to the strategic plans. These tactical managerial activities constantly evaluate reality in relation to the strategies, targets and performance measures, and adjust daily business activities accordingly. The tactical decisions include organizational structure, human resource management, financial control, production contracts, advertizing and promotional activities, etc. This indicates the dynamic nature of tactical management and shows that without a vision and strategic plan, tactical management will be more a matter of contingency and reaction than directional and proactive. Thus, the establishment of a vision and the development of a strategic plan sets the scene for guiding tactical managerial decisions that will lead to business success.

Managers develop and implement business plans

Management plays a facilitative role in developing and implementing business plans. Although some organizations may use a top-down approach to define the vision and strategies, the involvement of all the employees of the organization usually engenders greater ownership of the vision and more sincere determination to carry out the strategies defined. Likewise, involving shareholders and other stakeholders (e.g., target market, regulators and policy-makers) in the formulation of the vision will help to align intentions with possibilities and market requirements. Obviously, the more people directly involved in planning the more complicated is the process, but managers can include others through informal and formal input and discussion procedures. The key is to provide staff, shareholders and stakeholders an opportunity to provide input before the vision and strategic plans are defined, in order to achieve a measure of ownership and

commitment within the company as a whole. Since no plan can be rigid, and because the future is unknown, broad participation in the planning exercise gives everyone an appreciation of the need to be flexible in the seed business.

Developing the vision is a participatory and forward-looking process
The vision of a seed business is a brief description of the changes (internally, externally, or both) that the business expects to bring about as a result of its operations. The focus of the vision is the desired future state of existence related to the scope of business operation. Thus, the vision stands as an inspirational statement for the company, while also declaring to the world why the company exists. There are many ways of arriving at a vision statement—from a simple, few minutes, thought process, to a complicated and protracted analytical exercise. Whatever approach is taken, the aim is to create a statement that will give the company direction and a beacon to work towards. We present here a simple and flexible proposal that may be adapted, expanded or contracted as required.

Developing a vision involves a number of steps which emanate from the process of answering a "Trigger Question" that relates to the business' future but which is relevant to the current situation. Such a question may be as simple as, "What does this seed company want to achieve from its operations?", or, "What business are we in and for what purpose?" The nature of the question posed will depend, to a degree, on the present stage of business development, and what the current scenario of the company is (Box 2.1). Thus, the managers of a company must first have a good understanding of their present position as a company itself, and how it fits into the market and economic scenario of their immediate and extended world.

For example, a large, well-established regional seed company may be in a situation where it needs to consolidate its present position, and so the question may be, "What is required for this business to consolidate its recent gains?" Alternatively, in the case of a small, emerging business, the question may be more related to how to gain market penetration and recognition in the face of low seed purchase frequencies or serious competition.

The nature of the question may also depend on whether the company already has a vision statement or not. If a vision statement exists, the question may simply be, "Does our vision statement adequately reflect our business?" Thus, the formulation of the

"Trigger Question" itself will require some discussion and consideration of past and current business activity, and will be determined from the basis of whether the company needs a radical re-orientation or a refinement of present operations.

Once the Trigger Question has been defined, the steps to arrive at a vision statement include:

Step One: Hold an open conversation, using one or more structured procedures to better understand the nature of the business and the opportunities and threats that may exist.[2] The use of flipcharts, cards, small groups, brainstorming, etc., are useful means to gather ideas and insights from participants. This requires skillful facilitation, which is often best done by an experienced consultant, so as to avoid bias from internal management.

Step Two: Consolidate the ideas and insights gained into succinct summaries or groups of ideas under such headings as,

- *Customer Expectations*
- *Value Creation Promoters*
- *Success Influencers*
- *Success Hinderers*
- *Expected Business Benefits.*

[2]Further information on methods of strategic planning may be obtained from Hill et al. (2007), Kaplan and Norton (1996) and Steiner 1979, or at http://en.wikipedia.org/wiki/Strategic_planning.

Box 2.1 Reviewing the internal and external business environments

Key to making a successful business strategy is knowing where the company is today, both internally and externally. The external environment scan helps to define the scope of the business, opportunities that may exist, identify issues that might impact on the potential success of the business, or highlight constraints to what might be achieved. The internal environment scan may draw attention to areas of weakness, limitation or spare capacity. The following lists provide a guide to scanning the business environment. It may not be necessary to formally write responses to each of these points, but the lists serve as a check list of aspects of the business that needs to be evaluated either formally or informally.

Internal Business Environment

1. Business Governance
   a. Business formulation, i.e., constitution or legality of business establishment
   b. Current management organogram/structure
   c. Quality assurance procedures
   d. Compliance to national regulations on seed, safety, labor and finance
2. Financial Indicators
   a. Balance sheet indicators and ratios
   b. Profit and loss statement and ratios
   c. Historic cash flow cycle and current cash position
   d. Portfolio of banks and lending institutions and credit rating
   e. Accounting procedures and systems
3. Production Capacity
   a. Seed grower capacity and efficiency
   b. Seed grower contract definition and protocols
   c. Seed grower support services
   d. Conformance to quality standards (both internal and external)
   e. Processing capacity and efficiency
   f. Processing equipment adequacy and maintenance
4. Marketing Issues
   a. Product portfolio (crops, varieties and packaging)
   b. Current market share and competitive activity
   c. Pricing relative to competition and grain prices
   d. Customer perception of the seed business
   e. Brand identity and strength
   f. Complaints history
   g. Promotional material and distribution
   h. Customer support and sales services
   i. Current distribution network adequacy
   j. Stockist review (number, location, credit worthiness)
5. Personnel
   a. Staff complement and competency
   b. Job descriptions and performance
   c. Conditions of service and contracts

External Business Environment

1. Government and Institutional
   a. Seed Act and Regulations
   b. Variety Release Procedures
   c. Import/Export Requirements and Protocols
   d. Quarantine Procedures
   e. National Research Programs
   f. Public Variety Availability and Accessibility
   g. Intellectual Property Laws

2. Market Potential
   a. National or regional statistics on crop production and seed requirements
   b. Crop market prices and crop viability
   c. Population statistics, wealth and infrastructural (roads and retail) development
   d. Types of farmers, seed purchasing frequency and method, farmer organizations
   e. Potential for different types of seed, e.g., hybrids and OPVs
   f. Competitive activity
   g. NGO and seed relief activity
3. Production and Processing
   a. Farmers' capacity for producing seed (size of farms, infrastructure, ability)
   b. Cost of seed production
   c. Input supply
   d. Extension Services availability and accessibility
   e. Availability of processing facilities
4. Financial Security
   a. National financial policies and trends
   b. Inflation rate outlook
   c. Exchange rate fluctuations
   d. Interest rates

Step Three: From these summaries, pose the following questions, and answer them in one or more brief sentences:

1. *What change in our customers do we intend to bring about by our business?*
2. *What are the key elements that will contribute to our success in bringing about this change?*
3. *What do we have to do differently in order to achieve this success?*
4. *What must we stop doing that is presently hindering achievement of this success?*
5. *What benefit do we expect the business to gain from achieving this success?*

Step Four: Write a single sentence (or more, if necessary) that captures the essence of the answers to the questions posed in Step Three. This will form the basis of the vision statement. Traditionally, vision statements have been very short and succinct, but such statements usually do not convey much about the impact that the company hopes to make or what the company actually does. Thus, longer vision statements of 10 to 15 words, or even two to five sentences, are sometimes produced (see Box 2.2). Whatever the case may be, the vision ought to reflect the goal, values, competency and products of the company in a statement that can be easily understood and remembered.

Step Five: Review this vision statement to see if it adequately answers the "Trigger Question". If not, it may be necessary to return to Step Three.

Communicating and sustaining the vision promotes actions that move the company towards achieving the vision

Vision statements are meant to serve as a focal point and driver for business activity. All members of staff, management and owners need to subscribe to the statement and see it as their motivational driver. Consequently, the communication of the vision within the company becomes a crucial role for management. If a significant proportion of the staff has been involved in the formulation of the vision, this becomes an easier exercise to perform, but if only senior management have prepared the vision, then extra effort will be needed to diffuse the vision throughout the organization.

The use of media, such as posters, cards, letterheads, calendars, etc., to expose the vision statement is important, but inadequate. The vision must be the "talk" and "walk" of

management. They must champion it within the organization, so that everyone recognizes that this is the basic reason why the company exists. They must convey it to shareholders to give them reason to continue their commitment to the business. They must represent it to the world, in order for customers and competitors to know what the company stands for. As management inculcates the vision into their own daily work activity, this will permeate through to all those with whom they interact.

Box 2.2 A vision statement

Zambodia Seeds is an emerging seed company in a country with a relatively undeveloped seed sector. Although the company has only 16 permanent employees, the Owner-Manager prepared, together with the employees, the following vision statement:

"Zambodia Seeds contributes to increasing smallholder farmer viability by profitably developing, producing and marketing quality seeds of improved varieties of maize, beans and sunflowers."

This vision identifies the change the company intends to make to farmers' livelihoods, while indicating how it will achieve this.

It is not uncommon for a vision statement to be introduced in a flamboyant manner soon after its formulation. However, with time, it may fade into insignificance and forgetfulness. This may occur because the management simply does not recognize the importance and significance of the vision, or because the "busyness" of managing the company pushes the vision out of the way. Loss of vision will be one of the first steps to business degeneration. To avoid this, management needs to actively sustain the vision amongst the members of the organization. The only sure way of achieving this is to keep the vision "alive" personally, and by drawing attention to it in all business decisions, activities and processes.

The principal functions of managers are to plan and organize the business to progress towards the vision

As managers uphold the vision before the company, they have a principle by which to plan, implement, monitor and evaluate activities. The daily and momentary decisions that continually face managers must be guided by the vision. However, management is not simply a matter of decision-making. Their role is much more one of guiding decision-making throughout the organization. To do this adequately, careful and thoughtful planning and organizing is required. This involves identifying and arranging resources available to the company and allocating these to the various components of the business in a manner that will enable each of the divisions to function optimally and interactively. Responsibilities, progress markers, time frames, supporting services and expected outputs are specified and communicated to staff.

To implement the plan, management has a coordinating and leadership role that seeks to motivate people and allocate resources in such a manner that agreed activities may be carried out. While implementing the plan, activities and outputs must be monitored to ensure that the plan is being followed and expected results are being achieved. The issues that managers need to monitor include:

(1) whether the progress markers of the plan are being reached in a timely, effective and efficient manner;
(2) are the relevant support services being supplied?
(3) what are the factors that have influenced deviation from the plan; and
(4) what lessons may be learned from successes and failures in implementing the plan?

Such monitoring provides the means to evaluate progress and refine, re-direct, or continue activities in order to move the company closer to achieving the vision.

Leadership galvanizes activity to achieve the vision

Achieving the vision requires leadership from managers, but also from staff in all components of the company. At the heart of any business, even a seed company, are people. However good the variety portfolio of the company, no matter the size of the bank balance, or whatever the sophistication of the seed processing plant, a seed company will only be as good as the people involved, and their motivation and effectiveness. Thus, leadership of people is critical to achieving the vision of a company.

Leadership is not simply about having the top position and directing others. To be a leader is a serious responsibility, with few rights, and requires an attitude of service to those one leads. A leader is part of a team that works towards the attainment of the vision, and therefore a leader plays an interactive, supportive, coordinating and motivating role. Effective leadership largely hinges on leading one's self—having the self-discipline, personal vision, motivation and endurance to bring about change for the better, for the people served, the business and the world.

> The secret of success is constancy to purpose – *Benjamin Disraeli*

Next, leaders must express the character and integrity that they desire to see in those they lead. Therefore, selfishness, pride, immorality and dishonesty have no place in leadership. Since leaders lead people, they will tend to gather people around them who are similar to, or mould people under them into, their own character and style. The consequences of a leader's character will be evident in the followers and in the business they manage.

Third, good leaders are truly concerned about the well-being of those they lead, while not compromising on ethics and standards. Their aim is the highest good of all, but not at the expense of truth and virtue. Thus, when problems or issues of discipline are encountered, the aim is to find an equitable solution, while also securing the improvement of the people involved and maintaining good relationships.

Good leaders also recognize the strengths and skills of those in the team, and create opportunities and space for these abilities to be expressed. When team members perform effectively in their role, leaders give rewards that acknowledge performance and encourage further attainments. Furthermore, leaders are problem-solvers and opportunity harvesters—they anticipate, look for, and identify problems and opportunities, and make haste to overcome the troubles and utilize the prospective openings.

These, then, are a few characteristics of a good leader. Not everyone possesses all these, or is a born leader. But these characteristics may be learned and improved upon. Thus, leaders are also people who strive to grow in their skills and application of leadership principles. They hold up the vision and draw people along with them through growing servanthood and commitment.

Box 2.3 Strategic planning involves these aspects:

- It is oriented towards the anticipated future, and is aimed at creating the organization's future based on what this future is likely to look like.
- It is based on a thorough analysis of foreseen or predicted trends and scenarios of the possible alternative futures, as well as the analysis of internal and external data.
- It is flexible and oriented towards the big picture. It aligns an organization with its environment, establishing a context for accomplishing goals, and providing a framework and direction to achieve the desired future.
- It creates a framework for achieving competitive advantage by thoroughly analyzing the organization, its internal and external environment, and its potential. This enables organizations to respond to the emerging trends, events, challenges, and opportunities within the framework of its vision and mission, developed through the strategic planning process.
- It is a qualitative, idea driven process. It integrates "soft" data, not always supported quantitatively, such as experiences, intuition, and ideas, involves the organization in the ongoing dialogue, and aims to provide a clear organizational vision and focus.
- It is an ongoing, continuous learning process, an organizational dialogue, which extends beyond attaining a set of predetermined goals. It aims to change the way an organization thinks and operates, and create a learning organization.

Source: Adapted from A.L. Lerner 1999. College of Business Administration and Economics, California State University, Northridge.
http://www.des.calstate.edu/glossary.html

The three pillars of the business plan

The formulation of the vision of a seed company is only one facet of business leadership, albeit an important one. Added to this is the necessity of developing strategies to support the vision. For a seed company, three principle strategies need to be defined; namely, marketing, production and financial strategies. A strategy defines, by rules, guidelines and workplans, what needs to be done in order to reach the vision. Defining strategies is an iterative and interactive process between and within the components of the business, because these are all linked together and find their focus in the vision.

Each of the three strategies is like a leg on a three-legged stool (Figure 2.1). If one leg is missing, it is virtually impossible to sit on the stool. Likewise, if one leg is shorter or longer than the others, the stool will be unstable and extremely uncomfortable to sit on. Thus, each strategy is equally important to the business, and all three strategies must be formulated in order to sensibly work towards achieving the vision. Most seed business managers are strong in one or another of the components, depending on their background, education and skill, but this should not be a reason for ignoring those components in which there may be relative weakness.

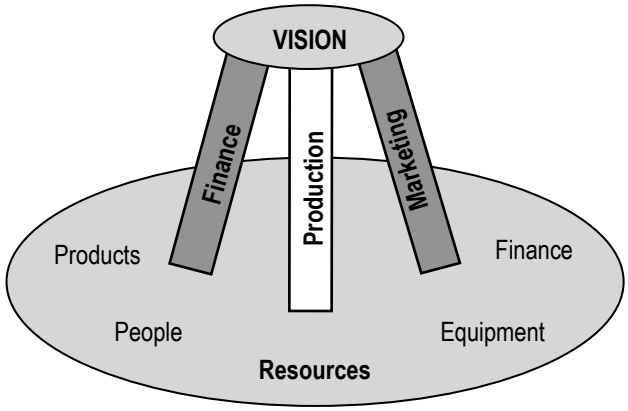


Figure 2.1 The vision of a company is supported by three legs or pillars—the marketing, production and financial strategies.

Note: These legs rest upon the resources of the company, which include the people, products, equipment and finances available.

The order of strategic plan development usually begins with defining the marketing strategy, for this basically defines the product portfolio and establishes the sales targets. With a realistic sales target, the next step is to define the production strategy, for this defines how the seed will be produced, processed, packaged and warehoused according

to pre-determined quality assuring procedures. The marketing strategy, in defining the sales targets, essentially establishes the potential income of the business, while the production strategy determines the major expenses of the seed company, particularly those related to the quantity of production. The financial strategy is the third step in the process, as it brings together the potential income of the sales targets and the expected costs of production, incorporates the overhead expenses of the company and determines whether the plan will be profitable and sustainable or not. Thus, the financial strategy is the one that determines whether the plan is feasible or not. The co-dependency of the three strategies is clearly evident from this description, and hence there has to be a high degree of interaction and iteration in the development of the three strategies. It may take a number of attempts before a realistic business plan can be achieved. Indeed, at times, it might require a re-examination and re-definition of the vision for it to be more specific and realistic.

The marketing strategy focuses on the customer's needs

The first part in developing the strategies of a seed company is to define the marketing strategy. On the basis of the vision, there will be the need to determine: what products will be marketed, what sales goals will be set, how to sell the seed and at what price. This strategy also includes those activities that will identify, inform, attract and service customers; how to compete with the competition and what will be done to make the actual sales. The kinds of questions that will be answered in developing a marketing strategy include:

"Our customers must experience the satisfaction of knowing that when they purchase our seed it will far exceed the quality and performance standards reached by our competitors."

Barry McCarter
Former General Manager, Seed Co Ltd, Zimbabwe.

- Who are the customers and what do they want?
- What is the size of the potential market?
- What relationships need to be established with wholesalers, retailers and farmers?
- How can the distribution network be established and supplied?
- How will current customers be maintained?
- How will new customers be attracted?
- What improvements or changes must be made to the product range?
- How will the company better compete with the competition?
- How will the product be priced?
- What credit facilities will be extended to wholesalers, retailers and farmers?

The production strategy ensures quality seed supplies

The production strategy establishes the plan of how to produce the seed to be sold. Seed production usually involves a number of stages, from breeders' seed through basic or foundation seed, to certified seed. The seed sold to farmers is certified seed. Thus, it usually takes three growing seasons to have seed available for sale, if the three stages are followed. In addition, there are issues of contracting seed growers, following certification regulations, seed processing and packaging, and quality assurance procedures. This therefore requires careful forward planning.

The production strategy will include the following areas:

- Planning the amount of certified, basic and breeders' seed to meet the sales goals.
- Contracting seed growers to grow the different classes of seed.
- Processing the seed into a saleable form, including cleaning, grading, dressing, packaging and warehousing.
- Conforming to the government seed regulations.
- Personnel (worker) management.
- Machinery and equipment management and maintenance.

The financial strategy puts in place necessary resources and controls for production and marketing

Most businesses will expect to increase production and sales with the aim of achieving higher profits. How will the increase in production be financed and how will the sales be translated into cash? Additional funds may be required to pay more seed growers, or more capital may be needed to purchase processing and packaging machinery. The Financial Strategy therefore brings the Marketing and Production Strategies together in an income and expense budget to see if the plan is profitable, develops a cash flow budget to ensure sustainable liquidity, and then works out schemes on how the plan will be financed, monitored and evaluated. The following points will need to be considered:

- Will the investment be profitable?
- How will the investments be financed?
- How will a loan be repaid?

Some of the tools that are used to develop the financial strategy are:

- Income and Expenditure Budget
- Cash Flow Budget
- Profit and Loss Statement
- Balance Sheet

Each of these three strategic pillars is presented in greater detail in the remainder of this book. For effective management and business success, all three pillars must be defined and managed optimally and interactively. Once these three strategic plans are made, they will form the basis of daily management activity and senior management analysis.

Tactical management to progress towards the vision

Vision statements and strategic plans are great and necessary, but they are not sufficient. They have to be put into action! Additionally, they have to be put into action in a timely manner, opportunely and with purpose! This is the task of the daily, minute-by-minute, tactical management by all employees of a company.

With the vision in mind, and the framework of strategies in place, the entire workforce of a company is ready for implementation. Managers have the special task of leading and guiding this activity through applying, adapting and improving activities according to the strategic plan. This is necessary because of the variable nature of the business environment. Consequently, managers need to constantly evaluate progress, identify problems and deviations from the intended course, and have a current understanding of the internal and external business environment.

Decision-making is a key function in tactical management. At the core of good decision-making is wise, logical thinking from a good knowledge base about information concerning the business. This highlights three ingredients in the process of decision-making:

1. Managers need information about the business. Information is not simply data, such as the quantity of seed in the warehouse, the number of seed grower contracts, or the current bank balance. It is data that has been sorted, analyzed, summarized, related to other sources of data and interpreted so as to determine significance and relevance to the current scenario and problem at hand. Thus, for example, concerning the quantity of seed in the warehouse, the manager needs to know the breakdown according to variety, age and quality in relation to original production targets and projected sales. Similarly, with the current bank balance, useful information would include the budget-to-actual difference, the current demands on cash, and the expected immediate and short-term inflows of cash.
2. General knowledge of the seed business is the backdrop by which information may be interpreted and applied to decision-making. Information alone will be worthless unless the manager has the general knowledge to understand how this information

might impact the business or offer solutions to problems faced. To gain this knowledge requires learning—applying one's self to knowing the internal business operations, obtaining knowledge about the broader seed sector and the agricultural economy both within the country and across the world from media, seed trade meetings, agricultural service organizations, grain markets, and so on. The more one knows about the seed business and the context in which one operates, the better the decision-making will be.

3. Finally, with good information and an extensive knowledge base, a manager will be able to analyze the alternatives and make a decision. The importance of a decision obviously determines how much time and effort is required to gather and analyze information before making the decision. Nevertheless, whatever the nature of the decision, it requires good thinking and a willingness to act. Logical thinking, coupled with wisdom, will permit good decision-making. However, good decisions do not come easily. There are a number of dangers to avoid, such as accepting the first option that seems likely to achieve the desired result, or being influenced by biases resulting from emotions, peer pressure, unwillingness to change, premature termination of the thinking process, favoring certain personal likes or avoiding outcomes that do not bring personal benefits. Perhaps the worst pitfall is not making a decision at all—this will only cause the problem to persist or result in the company missing an opportunity. If a decision is made that turns out to be wrong, that is not the end, but serves as a means of learning. Although not all decisions are revocable or recoverable, these are few in number and in most cases, companies can overcome poor or wrong decisions and capitalize on their mistakes.

Once a decision has been made, it must be communicated to relevant staff and implemented with zeal, commitment and in a timely manner. The purpose of communicating decisions is to ensure that all staff are aware of what the business is setting out to achieve. Again, this is where leadership plays a critical role. Leaders or managers rarely implement decisions. Instead, they motivate staff to achieve the intentions of decisions. The manager, therefore, acts as a coach to those who put the decision into action, encouraging staff, monitoring outcomes, and including staff in evaluating and improving on the outcome of the decision. This aspect of seed business management comprises a significant part of the manager's task, and is therefore one which must be given a great deal of attention with the determination to succeed.

Key thoughts

1. Seed business managers increase their ability to succeed if they:
   - establish a corporate vision of what the company intends to achieve for itself and her customers,
   - develop strategic plans for the marketing, production and financial functions of the firm, and
   - conduct daily management in a tactical manner in the context of the on-going operational environment.
2. The awareness of the company's place in the agricultural, economic and socio-political scenario acts as a backdrop to the company's operations and performance. Gathering and interpreting this information helps to develop and implement plans.
3. The vision, strategies and tactics of a business are not the exclusive domain of managers. While managers play a significant role in setting the vision, defining the strategies and implementing tactics, the participation of all staff in the process, at least in some meaningful way, will contribute to company-wide ownership and stewardship of the plan for success.
4. The vision may be defined on the basis of asking and answering a "trigger question" concerning the desired future of the company, taking into account the business scenario.
5. Strategies are founded upon the vision of the company, consider internal and external circumstances, and arrange medium-term business structure and modes of operation to enable the business to realize the vision.
6. Tactical management refers to the short-term, even momentary, decision-making, organization, motivation and leadership of the employees and resources of the company to implement strategies so as to progress towards the vision.
7. Managers ought to champion the vision, communicate the strategies and compose the tactics of the company, while motivating and leading employees to act in a coordinated manner.

3

Marketing Strategy

A seed company sells seed. That may be a simple and obvious statement, but at the heart of the matter, that is what the marketing strategy of a seed company is all about—selling seed. Although simple, the statement is nevertheless loaded with questions such as: Sell seed to whom? Sell seed where? Sell how much seed? Sell what kind of seed? Sell seed in what pack size? Sell seed at what price? ... Thus, the marketing strategy determines:

- What seed will be produced or procured for sale,
- To whom, how, when and where will the seed be sold, and
- What the sales' goals are in terms of volume and value.

The marketing strategy may be thought of as the key to the prosperity of the business, because without sales, there is no income, and without income there is no possibility of profit. Furthermore, it is pointless to produce or procure seed if it is not going to be sold. Thus, the marketing strategy is the "pipeline" of the business, for it channels the flow of seed from producers to customers, and serves as the means of generating value for the company.

The marketing strategy includes everything that needs to be done to sell products and services to customers. The two main components of this are:

1. **Match the customer and the product.** Farmers will only buy seed if it will be more productive and cost-effective than farm-saved seed (Box 3.1). Likewise, retailers will only stock seed if they are confident that it will be sold and thus earn them a margin. Furthermore, the kind of seed that you sell, together with the pack-size, quality, characteristics and price will determine who will buy the seed. Thus, the marketing strategy links the products of your business with particular customers.

2. **Understand and compete with the competition.** A seed company rarely exists alone in the market. And, even if it does, it faces competition from farm-saved

seed or imported seed. Therefore, a seed company must know who its competitors are and be prepared to compete with them. This requires the attainment of knowledge about the competition and its strategies, and finding out and implementing ways to sell seed ahead of the competition.

Matching the customer and the product

Marketing is the means of bridging the gap between production and consumption (McCarthy and Perrault 1990). In the seed industry, a number of "gaps" exist between the business and the customer, such as:

- Spatial gap: Farmers are dispersed over a large geographical area, while seed companies are usually located in towns and seed is often produced in particular locations that may be distant from customers. Seed companies need to find ways to make seed easily accessible to dispersed farmers.
- Time gap: Farmers require seed for planting at particular times of the year, while seed is produced one or more seasons ahead of the selling period. Seed companies generally have one chance annually to sell seed to farmers. If this is missed, significant financial problems may be faced.
- Information gap: Customers have certain preferences and requirements regarding the seed they wish to plant, while seed companies have information about the varieties on their portfolio. The seed company may be ignorant of what the farmer wants, while the farmer may be ignorant of what the seed company has on offer. It is required that seed companies match their products to customer needs.

Box 3.1 Farm-saved seed

Across Africa, farmers traditionally saved their own seeds from season to season and used their own experience to select and maintain their varieties. These seeds are commonly known as "land-races" and exhibit a large degree of variation and local adaptation. Much of this seed may be traded within and between communities through informal seed systems. Access to improved varieties that have been bred for increased yield, drought tolerance, disease resistance or other desirable traits, is usually through formal seed systems that include government, non-government and private seed multiplication and distribution schemes. Farmers who access improved varieties may retain a portion of the harvest for planting in forthcoming seasons. Thus, farmers do not always obtain fresh seed of improved varieties from the formal seed sector on an annual basis, but utilize farm-saved seed, either of land-races or improved varieties.

The impact of farm-saved seed of improved varieties on crop productivity is a function of the type of crop, the type of variety and the on-farm seed storage conditions. Poor seed storage of farm-saved seed will have a negative impact on germination capacity of the seed. Farm-saved seed of improved self-pollinating crop varieties will perform similarly to purchased-seed. The reduction in performance of farm-saved seed of open pollinated crops will be a function of the extent and source of foreign-pollen contamination, and the effect of self-pollination on the crop. Retention of grain from hybrids, especially single-cross hybrids, for use as seed is significantly detrimental to subsequent crop performance.

- Value gap: The seed company values its seed in terms of price and attributes, whereas customers value seed in terms of what benefits will be derived from the production arising from the seed. Setting seed prices at a value that will convince farmers to buy is therefore key to securing seed sales.

The marketing strategy is largely about how to bridge these gaps, with the recognition that the customer determines the product and the product determines the customer. Consequently, the more knowledge a seed company has about the target customers, the better the needs of the customer can be met.

Identifying and understanding the target market

A target market is the specific set of customers to whom the seed business aims to sell its seed and services (Scarborough and Zimmerer 1988). At the macro level, the target market may be perceived as all farmers who grow the crop for which the company has seed for sale. In a recent survey of maize seed supply in nine eastern and southern Africa countries, the average adoption rate of improved seed was in the order of 35 % (Langyintuo et al. 2008). Based on the estimated area of maize grown in these nine countries, the quantity of maize seed planted was about 295,000 t, but the market size for improved seed was only 103,500 t. The apparent potential for growth in the seed market is therefore great, particularly in countries with a current low adoption rate of improved varieties (such as Angola, Ethiopia, Mozambique and Tanzania).

However, seed markets are not simply determined by these macro-statistics. Seed is bought for and by farmers under many different and spatially disparate situations. For example:

- An individual farmer may buy 2 kg of seed at a small rural stockist;
- A farmer's son working in the city may buy 25 kg of seed at a large supermarket and send it to his mother living in a rural area;
- An NGO may purchase 500 t of OPV seed packed in 12.5 kg bags for distribution to farmers recently affected by a flood;
- An agro-dealer may purchase 5 t of seed for stocking his network of rural shops; and
- A government tender may call for 6,000 t of seed for a seed distribution program.

Each one of these customers has a different need and profile, while they all exist within the context of the seed supply systems of a country, which includes the formal and informal sectors, and farm-saved seed systems. Thus, the identity of the target market is not a simple exercise, but requires a thorough analysis of the seed systems within the market range of a company. Some of the questions to be answered in establishing and understanding the target market include:

1. Questions related to the geography and agricultural business of the target market. For example:
   - What geographical area do we intend to sell seed to?
   - What is the infrastructure of this area, where are the main business centers, government extension service centers, road networks, agro-processing plants and input supply companies?
   - Where are the main crop production zones and irrigation schemes?
   - What are the main crops produced, how are they sold and what are the seasonal price profiles?
   - What NGOs are operating in this area, and what services and programs are they providing?
   - Who are the key political figures and business leaders in the area?
2. Questions related to the customers in the target market area. For example:
   - Who are the intended customers—individual farmers, farmer associations, retail shops, wholesalers, government agents and/or NGOs?
   - What are the characteristics of these various customers? Different questions will need to be asked of each type of seed buyer, but, in general, information about their demographic characteristics, income levels, buying patterns, usage patterns, cropping methods, environmental conditions and risk status should be gathered.
   - What are the seed products and the characteristics needed by customers in the target area?

As a seed company evaluates the target market, the managers must be satisfied that it is large enough to warrant investment in product development, production and sales; it must be accessible so that products may be easily distributed into the market, and it should have long-term prospects since the seed business has long product development and scale-up cycles.

Recognizing market opportunities

Opportunities in markets may come from four quarters (Figure 3.1). A seed company exists with a present market share and a particular product portfolio within a given market. The first opportunity is to grow the share of total volume within an existing market with the company's present product portfolio. The principle marketing strategies here will be to compete with the competition through promotion, improved distribution, competitive pricing and product support. However, the achievement of an increased market share will ultimately depend on whether the present product portfolio and seed accessibility is suitable to the product needs of the customers in the market.

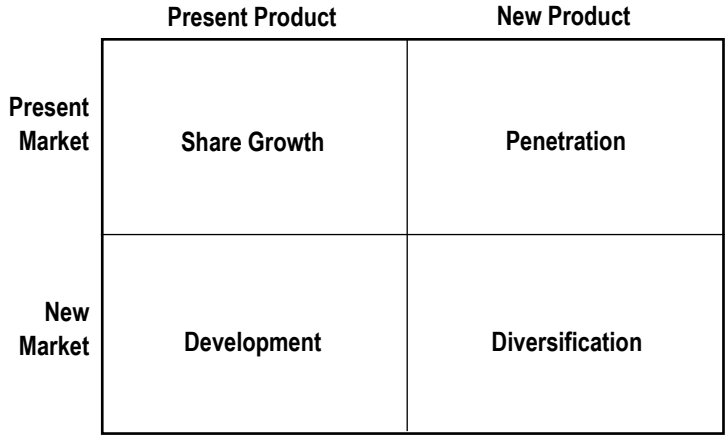


Figure 3.1 The four principal marketing opportunities open to seed companies.

A second opportunity is to launch new products within an existing market, either to replace obsolete products or provide new alternatives to customers. This may or may not lead to an increase in market share. The principal aim here is to provide customers with a better product selection. Thus, strategies that will successfully launch the new product into a competitive market will be at the forefront. These combine promotion and seed provision, but of the two, seed availability is key to the success of this strategy. Many a good product has failed because of lack of seed, whereas a good and appreciated product will almost sell itself if farmers have access to the seed.

Opening up new markets with existing products presents a third opportunity to a seed company. These new markets may be within the country of operation, or in foreign countries where the products will perform reliably. Similar to this, is the opportunity of entering new markets with new products. The development of these opportunities must be preceded with thorough testing of products to confirm their adaptability and suitability to the intended customers. Then, the question of how to enter the new market becomes important. In foreign markets, the easiest initial step is to export seed from the home base into the new market and distribute

Box 3.2 What is a "product"?

A product is whatever a company sells to satisfy a customer's need or want. A tangible product may include a number of intangible benefits to the customer, such as information, service, skills and satisfaction. For a seed company, the principal tangible component of a product is the seed itself, but the seed contains an intangible genetic potential, and comes in a certain pack size and may be coated with chemicals. A seed company's product also has many other intangible characteristics, such as any information and services that the company supplies with the seed. A seed company needs to define what their products are in order to know how to market them effectively. Some of these characteristics may be more important to some customers than to others, while also presenting opportunities for competing with the competition.

through a local distributor. However, in some new markets it may be necessary to establish local seed production operations and offices. Once a foothold has been gained in a new market, marketing strategies are concerned with growing the market through product promotion and competing with the competition.

Understanding the customer's buying criteria

A customer will buy a product only if it meets at least four criteria:

1. **The customer must need the product** (for a definition of a product, see Box 3.2). In the case of seed, the potential genetic value contained in the seed and any other additional items associated with the seed supplied by a company must be of greater value to the customer than what is in farm-saved seed or in other accessible sources of seed. Thus, in order to buy seed, the customer must recognize his/her need for that seed, appreciating the value and usefulness of the seed.

   Determining the seed needs of customers forms an essential component of the marketing strategy. Not only is this to be defined in terms of genotype (varietal characteristics), but customers also have needs concerning the seed pack and the seed quality (see Box 3.3). The only way to know what these needs are is through talking with customers, and showing them options and surveying their likes and dislikes. Furthermore, customers need to have information about the seed products available to determine whether what is on offer meets their expectations. Thus, information provision over and above advertising is an essential component of the marketing strategy.

Box 3.3 Checklist of customers' needs with respect to seed

Qualities related to the seed pack

- Size of pack—weight and kernel count
- Packaging material—durability and functionality
- Labeling and information—regulatory and educational content; understandability
- Attractiveness and legibility

Qualities related to the seed itself

- Purity—absence of foreign seed and varietal purity
- Phytosanitary—disease and pest free
- Physical quality—free of defects
- Seed additives—appropriate pesticide application(s)
- Color coating—attractiveness and acceptability
- Seed grading—size, shape and uniformity of seed in a pack

Qualities related to the variety

- Yield potential and stability—adaptability and appropriateness for the farmer's environment
- Defensive traits—pertinent disease resistance, lodging resistance, tip coverage, pest and herbicide tolerance, maturity, and abiotic stress tolerance
- Utility traits—grain and meal color, texture, poundability, milling out-turn, taste, nutritive value, shellability, storability, cooking quality, etc.
- Aesthetic traits—plant and ear height, phenotype, ear posture and uniformity

Qualities related to service

- Accessibility to seed, including delivery
- Support, such as agronomic advice, complaints management, literature
- Payment methods—discounts, possibility of credit purchase, etc.
- Field days and demonstrations

The aim in product development is to meet customer requirements in all the basic characteristics plus additional unique attributes that will serve as the main selling points of the product. The basic characteristics of seed products that apply to the whole product portfolio will include seed quality expectations, seed packaging standards, plant aesthetics, and basic varietal performance in terms of yield potential and agronomic performance. The unique selling traits then become the defensive and utility traits of the variety, such as drought tolerance or milling quality, which reduce production risks and add value, respectively.

2. **The customer must like the product.** Even if the product meets a need of the customer, the customer will not buy it if he or she does not like it. This has much to do with the aesthetic characteristics of the seed pack, seed appearance, growing plant and final grain product. The product must be attractive. Consequently, value for cultivation and use is not the only criterion that a farmer or customer will use to purchase seed. This matter of like or dislike may even extend beyond the essential characteristics of the seed to the company image and service provision, commonly conceived of as the company brand. Brand establishment and maintenance are therefore important to the marketing strategy.

Brand awareness and product awareness are not equivalent. The brand supports the product, and helps the customer to identify the product with something familiar. Indeed, a strong brand may positively influence a purchase decision, especially in the scenario where a customer is faced with a choice of similar but competing products. Branding is therefore a means of creating distinction and differentiation in the market.

The brand is not the corporate logo *per se*, although it includes it. The brand is a broader perception of the customer concerning the seed and the company. Thus, the brand is the immediate image, emotions and perceptions consumers experience when they think of your seed company and its products. It is, therefore, all the tangible and intangible qualities and aspects of the seed company and its products. Building the company brand through the provision of quality seed of consistently performing varieties, supported by excellent service, and couched in eye-catching and informative packaging and advertising, will go a long way in attracting and maintaining customers. Ultimately, however, brand strength is built through congruency between product portrayal and product performance in the field. As farmers find satisfaction and real benefits from using a company's seed, confidence in the company will increase so that the company's brand is recognized as reliable and valuable.

3. **The customer must be able to afford the product.** Even if the customer needs and likes the product, the price may determine whether the product is purchased or not. Setting the seed price therefore constitutes a significant part of the marketing strategy. Internal factors to consider include the cost of production, volume of sales, margin required to cover operating costs, profit expectation and capital expenditure requirements. External factors include the seed price relative to the customers' costs of production, customers' cash availability and value perceptions, competitive uses of the customer's scarce cash resources and pricing levels of competitor seed companies. Some methods of setting the seed price are discussed below.

Setting seed prices at a value that will convince farmers to buy is key to securing seed sales.

4. **The customer must have access to the product.** This is an aspect of the marketing strategy which is possibly the most difficult to define, since farmers are dispersed over a wide geographical area and as individuals, they purchase relatively small quantities of seed. Establishing a distribution network that provides farmers with easy access to seed is therefore critical to success. To achieve this requires the formation of partnerships, agencies or dealerships with agro-dealers, wholesalers, farmer associations, NGOs, crop commodity dealers, and agro-processors. Additionally, support to these distributors in terms of credit facilities, information provision, customer service, merchandising, advertising and complaints management, will promote customer awareness of products and selling points.

Box 3.4 Impact of farmers' choice of variety

Farmers make the choice of which variety to purchase, but seed companies may have a significant role in influencing purchasing decisions through distribution and promotion. What then are the possible impacts of a right or wrong choice of a variety by a farmer?

Right choice of variety:

- The farmer has the best chance of benefitting from the genetic potential of the variety.
- The farmer is likely to purchase seed of the variety again.
- Farmers gain confidence in adopting improved varieties.

Wrong choice of variety:

- The farmer is unlikely to achieve desired crop productivity.
- The farmer is unlikely to purchase seed of the variety again.
- Farmers' confidence in adopting new varieties decreased.

While considering how to give customers access to seed, also look for ways to expand markets to new customers. There may be businesses and organizations that have been overlooked as potential distributors, such as supermarkets or service stations. The employment of farmer-agents or roving sales personnel may enable closer contact with

rural farmers, rather than selling through centralized retail stockists. Seed fairs have also been promoted by NGOs as a means by which informal and formal seed traders may avail seed to rural farmers. Advertising through various media, especially community radio stations, may help to extend the name and product portfolio of the seed company to areas not covered by the traditional media. Lastly, the use of field demonstrations and field days exposes passersby and target audiences to products and creates interest in the seed.

Seed price determination

Determining the seed price is a complex process since there are many internal and external factors to consider. By definition, the price is the exchange value of a product or service, usually stated in monetary terms (Hutt and Stull 1992). On the side of the seed company, the price of a product is the primary determinant of production and the means of earning income, while for the customer the price is the cost of acquiring value, benefit or utility, and determines the quantity purchased. High or increasing prices means greater profits and opportunities for growth for the company, whereas for the customer, they may mean reduced purchases or alternative purchases (Kohls and Uhl 2002). The price therefore acts to regulate company outputs and income, and consumer purchases.

The following are factors affecting seed price:

1. A product's price does not exist in isolation in the market, but is always relative to the price of substitute products. The relative price, and not so much the absolute price, of a product, determines customers' choices. With reference to seed, the relative price to farm-saved seed is the basic relationship that drives purchase decisions. This is particularly the case for self-pollinated crops, for they are true-breeding and farm-saved seed is potentially of similar value to purchased seed.

   For maize seed, particularly hybrid maize seed, farm-saved seed suffers a yield penalty. As a result, the relative price is more in favor of purchased seed. CIMMYT research has found that farm-saved seed of improved OPVs yields about 95% compared to fresh seed of the same variety. On the other hand, farm-saved seed of a three-way hybrid yields about 68 % that of fresh first generation (F1) seed of the same variety. Other substitute products in the seed industry include alternative products of the same crop, such as OPVs and hybrids, whether from the same company or from competitors, and alternative crops. Therefore, when determining seed prices, one must bear in mind the relative price of products, with their various alternatives.

2. The supply and demand relationship is a major factor in price determination, particularly in a competitive market economy. According to Kohls and Uhl (2002), demand is the "schedule of different quantities of a commodity that buyers will purchase at different prices at a given time and place." Simply put, the lower the price, the more the seed that will be purchased, and vice versa. With respect to supply, this is the "schedule of differing quantities that will be offered for sale at different prices at a given time and place" (ibid.). Thus, the higher the price, the more will be offered for sale, and vice versa. The demand and supply curves indicate the relationship between quantity and price from the buyers' and sellers' perspectives, respectively. Theoretically, the equilibrium price is that point where the demand and supply schedules intersect.

   The price elasticity is a measure of the responsiveness of quantity supplied and demanded to changes in price (ibid.). With an elastic demand for a product, if the price decreases by a certain percentage, the amount purchased would increase by a greater percentage. In other words, if the price decreased by 10%, the change in quantity purchased would be greater than 10%. Conversely, with an inelastic demand, the amount purchased would increase by a lesser percentage than the percentage price decrease. The elasticity of demand is related to the number of substitutes for the product. Necessities with few alternatives have inelastic demand curves, since consumers will generally always buy the product regardless of price. Luxury goods have elastic demand curves, since reduced prices will generally significantly increase demand.

   The demand and supply curves of a product are not static, but dynamic. There are basically four possible scenarios. For a given supply, demand may increase, such that seed price may be increased without reducing sales. Second, supply may increase for a given demand with the result that prices need to be reduced to achieve the same sales quantity. Third, demand decreases while supply increases, again necessitating reduction in price to achieve the same quantity of sales. And, fourth, both demand and supply increase, such that prices remain unchanged but sales volumes increase. Consequently, a seed company must constantly monitor the supply of seed, both from their own production and that of the whole seed sector, and the demand for seed from the farming community.

   The demand curve for maize seed may be considered both on an individual farmer basis and on a collective basis. On the individual farmer basis, particularly

smallholder farmers with small fields, the demand for seed is basically fixed by the field area and cropping patterns. Where the staple food is maize, for example, a farmer will plant an area of maize that will be expected to meet the family's food security. The remainder of the fields will be planted to supplementary food crops (e.g., groundnuts and beans) and cash crops (e.g., cotton). More land will only be taken out of other crops and committed to maize if the grain market for maize is more profitable than other crops. On a collective basis, the demand for maize seed is therefore closely related to the value of the potential grain market and the mix of farm-crop alternatives. Since each farmer will grow maize for food security, it may be thought that the demand for seed is inelastic, but this depends on the extent and relative performance of alternatives, such as farm-saved seed, OPVs and hybrid varieties. Thus, the demand curve for maize seed is elastic, especially when the other crop alternatives are considered.

On the supply side, seed exhibits a relatively high elasticity of supply. Seed producers will respond positively to increased seed prices, particularly if these are announced pre-season. However, the converse is also true: seed growers will turn to alternative crops if the seed price offered is relatively less profitable. This fact has been borne out in countries where governments have imposed unrealistic price controls on seed. Legislated low prices that lead to reduced profitability provide little, if any, incentive to produce and supply seed to the market.

3. The seed to grain price ratio and the productivity of farmers exerts an influence on seed purchasing. Thus, in order to set affordable seed prices, a marketing manager will need to know the current or expected grain prices for the crop to be planted, and the productivity of target farmers. For farmers who have a choice of using farm-saved seed, OPVs or hybrids, the ratios of these to the grain price will influence the break-even yield needed to cover the seed cost (Figure 3.2). As the seed:grain price ratio increases, farmers need to produce more grain to cover the cost of the seed. Consequently, the higher the productivity of grain production, the lower the proportion of the harvested crop required to cover the seed cost. Similarly, seed costs become a smaller proportion of the costs of production as yields and income increase. In general, if maize farmers produce more than 1.5 t/ha, it is to their advantage to use hybrid seed.

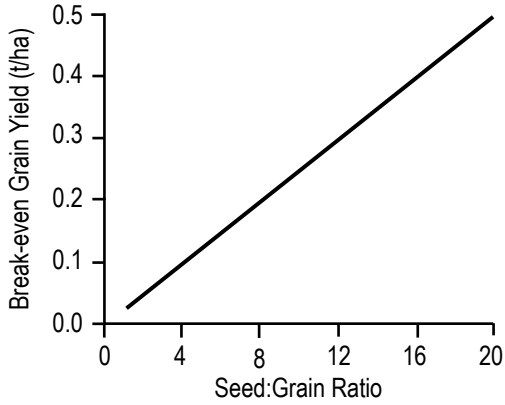


Figure 3.2 The break-even grain yield needed to cover the cost of seed as a function of the seed to grain price ratio (assuming a seeding rate of 0.025 t/ha).

Thus, higher seed prices will only be sustainable in markets where farmers are highly productive, grain prices are relatively good and grain markets are accessible. This is evident in the way seed prices varied across Africa in 2008. In South Africa, where commercial farm maize yields are high, particularly under irrigation farming, the price of a three-way maize hybrid was in the order of US$ 2.5 to 4.0/kg. Single-cross hybrids and hybrids containing genetically modified traits had seed prices greater than US$ 5.0/kg. Conversely, in other Africa countries where average smallholder maize yields are relatively low, three-way hybrid seed sold at US$ 1.2 to 2.0/kg.

4. Independent factors outside of the control of the business, such as government controls and exchange rate fluctuations. Since these are mostly outside of the control of the business, there is little that can be done to mitigate their effects. However, in the case of government controls, lobbying and negotiation can help to set acceptable price levels. With some of the other external factors, strategies that reduce exposure and risk, such as insurance or strategic borrowing may help.

Setting the seed price

The turnover of a company is the product of the volume of seed sold and the unit price. But, as already indicated, price affects sales volume. Consequently, in setting the seed price, one has to be clear on the overall objective (Machado 1996). If the objective is to increase profits, then it is necessary to set a price that will achieve the highest margin over total costs. However, if the objective is to increase market share, then pricing will be more related to the prices of competitor products than margins *per se,* while also taking into account the customers' response to relative prices. As noted above, for a given demand, the only way to increase quantity sold is to reduce prices, which will

inevitably lead to reduced margins for a given cost structure. Thus, any price reductions aimed at gaining market share must be accompanied with increased sales' volumes in order to achieve profit growth. Alternatively, if the intention of the company is to grow sales volumes amongst customers who have not been purchasing improved seed before, pricing must be related to grain prices and those of alternative seeds and products. Finally, in some cases, prices may simply be set at a level that will ensure survival of the business, in which case, break-even pricing is the predominant thought.

Setting the basic price of seed may be according to three methods, namely, cost-oriented pricing, customer-oriented pricing and competitive pricing (Kotler and Armstrong 1994; cited by Machado 1996). In some cases, there may be an administered pricing system, regulated by the government. This need not necessarily be prejudicial to a seed company, provided the price is reasonably negotiated between the three parties involved (i.e., farmers, seed companies and the government). Examples of calculating seed prices follow.

1. Cost-oriented pricing

In this method of calculating the price of seed, the cost of sales (or cost of goods sold, COGS) and operating expenses (sometimes called overheads) are taken into account. The simplest method is to calculate a margin over the cost of sales (Box 3.5), which when accumulated will be sufficient to cover the operating expenses and provide for a net profit. Alternatively, the seed price may be calculated by including the operating expenses and the expected volume of seed sales. However, this method is difficult if more than one product is being sold, because the operating expenses have to be distributed across the various products.

Box 3.5 Cost plus margin pricing

In its simplest form, the price equals the cost of sales plus a margin. The formula for this calculation is,

Price = Cost of Sales / (1 – Gross Margin)

For example, if the cost of sales of a hybrid is $720/t, and the required gross margin is 40 %, then the seed price is $1200/t,

i.e., 720 / (1 – 0.4) = 1200.

This method may be refined by considering the operating expenses, volume of seed to be sold and the required net profit. First, the unit cost of the seed is calculated and then a margin is added to derive the price. Thus, if

Cost of sales = $720/t,
Volume of seed to be sold = 800 t,
Operating costs = $160 000, then

the unit cost of seed is calculated as,

Cost of Sales + (Operating Costs / Sales Volume)

Thus, for the example:

Unit seed cost = 720 + (160 000 / 800)
= $920/t

If the desired net profit is 25 %, then the seed price is calculated as

Unit Seed Cost / (1 – net profit).

Thus,

Seed Price = 920 / (1 – 0.2)
= $1150/t

2. Customer-oriented pricing

Setting seed prices with customers in mind, considers other factors apart from required internal margins. In principle, the price is determined by estimating what customers will be prepared to pay for particular products. This method will therefore take into account the production costs and circumstances of farmers, together with the value of the seed in terms of quality and genetic potential. For example, as the yield potential of maize farming increases through intensive management and greater input application, seed becomes a smaller proportion of the total costs of production. Consequently, it may be argued that such farmers will be prepared to pay a higher price for seed, particularly if the seed presents greater genetic value than alternative varieties.

Alternative methods of customer-oriented pricing may include:

- premium pricing for new varieties or for seed that bears unique traits (whether related to genetics, packaging or seed dressings);
- pricing seed based on the product mix available, for example, pack size; and
- reduced pricing so as to attract new customers, especially where new markets are being explored or to gain market share.

3. Competitive pricing

The seed market is competitive. There are few instances where there are no alternatives to a company's products, either from other seed companies or farm-saved seed. Setting prices relative to the competition has to be done with careful forethought, taking into account your relative product qualities and brand position. Undercutting competitors may quickly result in a price war that has few winners other than the customers. Furthermore, customers may be skeptical of products with significantly lower prices than competitors, for they may think this is due to product defects. Setting prices significantly above competitors, while possibly being justifiable for your company, may gain little sympathy in the market, unless there is real value to the customer. Consequently, prices must be set at a level that will be accepted in the market and promote sales of your products.

Having calculated possible prices for products, these have to be inserted into the matrix of the whole company's budget to ensure that a net profit will be achieved. This requires that the sum of the expected volumes of seed sold multiplied by the prices of each product, less the operating costs, will provide sufficient net profit for sustainable business operation. At this stage, it may be found that prices are too low to achieve the desired net profit, and new calculations will have to be made. Or, if higher prices are not possible, due to market forces, then either sales volumes or operating costs may need to be re-evaluated.

Whatever method a seed company uses to calculate the prices of its products, there will always be an element of "price discovery" in the market (Kohls and Uhl 2002). This is the process by which sellers and buyers arrive at specific prices for a given transaction. This is related to the relative bargaining powers of the buyers and sellers, and the conditions of sale. Consequently, the actual price at which a seed company sells its product will depend on who and where the buyer is (e.g., city wholesaler, rural retailer or individual farmer), what quantities of seed these buyers intend to purchase, and the trading terms of the transaction. Individual farmers have less buying power than collectives or large-quantity buyers. Small-pack seed may be able to command a higher unit price than large-pack or bulk seed. Provision of discounts, commissions and credit sales has the effect of lowering the real price. This requires that a pricing policy be established for the various types of product, purchasers and transactions. Once set, this must be communicated to sales' staff, other company departments and customers, so that the business of selling seed may proceed smoothly without confusion.

Product life-cycle management

Seed is a means of providing genetic potential to customers. Since seed is grown in an environment that is changing with respect to climate, biotic stresses and consumer preferences, the genotype may become challenged or unacceptable, particularly as other improved varieties enter the market. Thus, a variety will likely have a product life-cycle, which implies four things:

1. Products have a limited life span on the market, which in the case of seed is related to changes in biotic and abiotic factors, and shifting market demands;
2. Product sales pass through distinct stages, from development to maturity, each posing different challenges, opportunities and problems to the company;
3. Profits rise and fall at different stages of the product life-cycle; and
4. Products require different marketing, financial, manufacturing, selling and human resources strategies in each stage of the life-cycle.

A schematic representation of a product life-cycle is presented (Figure 3.3). The development of a new variety is a costly and time-demanding exercise, but once it is launched onto the market, income is earned through sales. Consequently, profits are expected to grow as sales' volumes increase. Usually, a product will reach a stage of maturity where sales' volumes plateau, and may, due to various factors, decline. The length of the product life-cycle and shape of the sales and profit curves will vary from product to product. Marketing activities, especially promotion, may shorten the introductory phase, increase the rate of the growth phase or extend the maturity phase. Similarly, seed production scale-up may greatly impact on the duration and scale of

each phase. Many a new variety has simply failed to penetrate a market because of lack of seed production. Furthermore, competitor activity, or changes in the agronomic practices of farmers or emergence of new diseases may curtail the life of a variety.

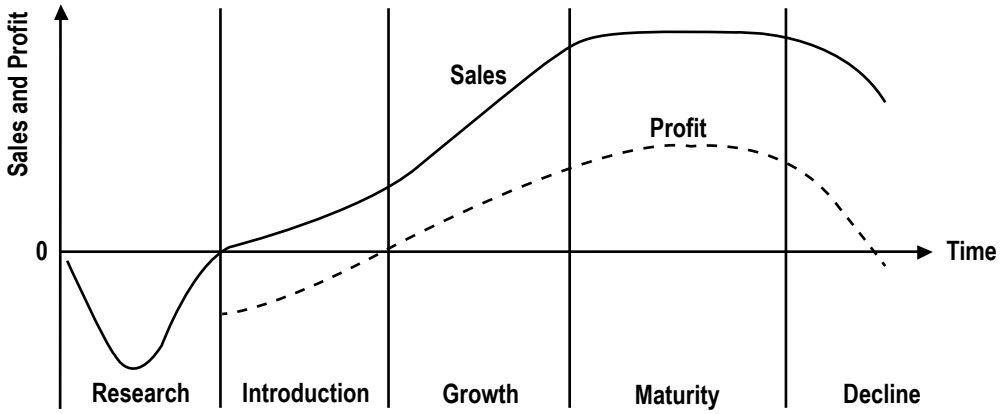


Figure 3.3 Schematic representation of a product life-cycle.

The average length of a product's life-cycle in a seed market is also related to the number of new varieties registered annually. In some countries, variety registration is infrequent. Hence farmers have few opportunities to access and benefit from new varieties, and products exist for a long time in the market before new varieties become available. The opposite is true in South Africa, where seed companies register numerous products annually, and nearly 75 % of varieties on the national registry are less than seven years old (E. Goldschagg, SANSOR, personal communication, 2009). However, there are a few varieties that have maintained market presence for very long periods. The most notable is a single cross hybrid from Zimbabwe, SR52, released over 50 years ago and which is still in demand, particularly for the boiled green maize market in South Africa.

The management of the product life-cycle revolves around monitoring the growth of sales and the relative market share of products. This has been formulated into a scheme known as the "Boston Matrix" (Figure 3.4; Henderson 1973). A product will usually begin its life-cycle as a "question mark," in that it has taken significant investment to launch it onto the market but has yet to be tested and approved in the actual market place. If the product does attract market attention and begins to grow in sales volume, it is considered a "star". "Stars" are those products with high sales' growth rates and which have the potential to increase their market share. Products that have gained a relatively large market share are termed "cash cows", since they generally make a significant contribution to profit, all things being equal. It should be noted, however, that market share alone is not a measure of a product's contribution to gross profit. A

product with a low market share may have a greater gross margin, and hence contribute more to gross profit than a product with a similar or higher market share but a low gross margin. Products that are questionable are those with a high market share but low relative growth rate, while the "dogs" are those with low market share and low growth rate.

The ideal marketing situation would be to have all products as cash cows or stars, but this is not normally practical or possible. Generally speaking, in a portfolio of many products, there will be one or more products in each category. Most investment in marketing activities should be applied to rising stars and cash cows. If sales of a product begin to decline it may be possible to "re-invent" the product through promotion (e.g., with discounts and advertising) or modifying the product in some way (e.g., using new packaging or applying a new seed dressing). However, if the sale volumes of a product continue to decline it may become a "dog". In this case, if it is not possible to restore sales through production and promotion, it should be phased out as fast as possible to minimize losses. Furthermore, since products tend to go through these product life-cycles, it is necessary to maintain investment in research and development so as to ensure a continual supply of new entrants to the market. If a "dog" product is not replaced quickly with a rising star, significant market share may be lost, with a concomitant negative impact on business performance.

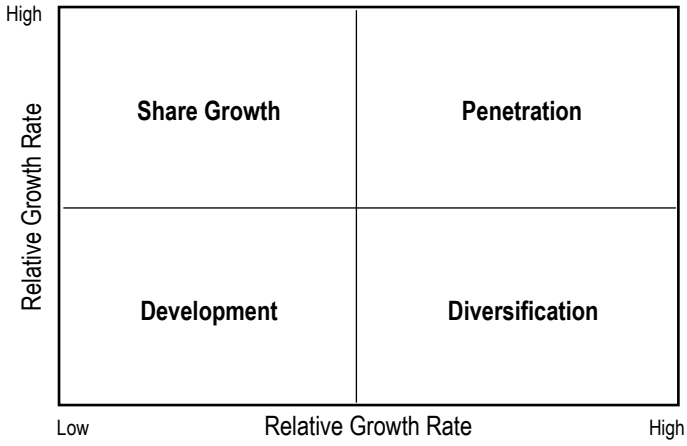


Figure 3.4 The "Boston Matrix".

Note: This figure illustrates the various scenarios through which a product may go in its life-cycle, from inception ("question mark") through growth ("star"), increased market share ("cash cow") to declining growth ("dog").

Source: Henderson (1973).

The total seed sales of a company comprise the sum of the sales of the individual varieties in the product portfolio. Keeping track of the sales figures and proportional contribution of each product to the total is helpful for managing promotional activities and setting production targets. If total sales are increasing or decreasing it is important to know which products are rising or falling in their sales and which contribute most to the change in total sales. In the hypothetical example presented (Figure 3.5), total sales in the first five years show a small increase. Although the majority of sales were contributed by one variety (B), the total increase appears to have also been due to the introduction of a new variety (C). This new variety helped off-set the decline in sales of variety A. From year 10 to 15 the sales volumes of variety B declines, but total sales continue to increase due to the introduction of new varieties. Around years 15 to 17, total sales peak, but no single variety is the major contributor. Rather, three varieties (B, C and D) each contribute 30% to 35% of sales.

This simple example serves to illustrate the dynamics of the variety portfolio of a seed company. Varieties will have a life-cycle due to customer preferences, competitor influences and changes in the bio-physical environment. Seed companies that rely on only one variety or those that do not have an active variety development strategy to introduce new varieties are likely to face marketing problems when the market changes.

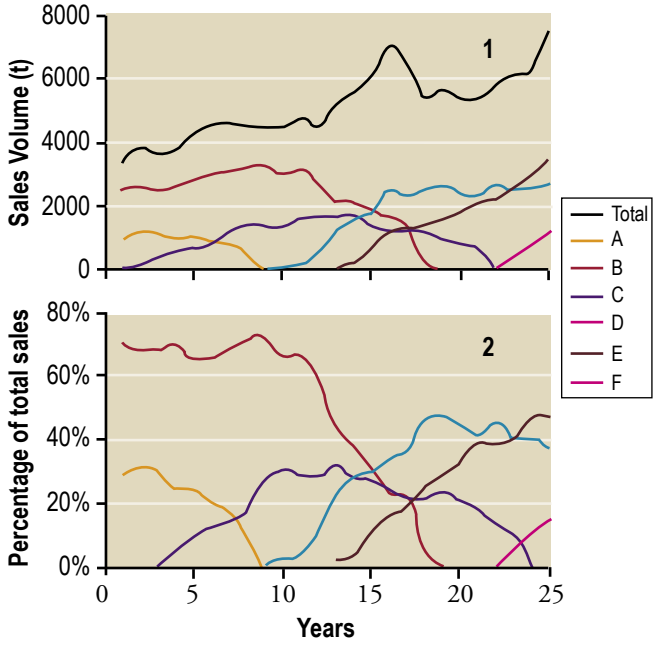


Figure 3.5 Hypothetical sales' volumes of six varieties.
Note: These are A through F over time, and their (1) absolute and (2) proportional contribution to total sales over time.

Sales promotion strategies

Promotion of seed sales is the most noticeable component of a marketing strategy. This is the way a company presents itself and its products to customers and the public. In essence, promotion is about effective communication in which the recipient rightly receives and understands the messages given. Successful communication rests on the clarity, simplicity, memorability and interest value of the expressions. However, in any communication, there is the risk of misunderstanding, for the message sent may not always equal the message received. Poor communication may result in unintended consequences and undesired responses, which is to be avoided. Therefore, make every effort to ensure positive communication.

Communication originates from a source, contains a message and is channeled to a recipient via media. A recipient of a communicated message exists within his or her own context. This influences the way the message is received. The recipient also has certain perceptions about the source of and media used for the message which will further influence the way the message is received. Therefore, in preparing sales promotion strategies, it is not the message alone that has to be determined, but consideration of the overall company image, the channel of delivering the message and the situation and circumstances of the recipients has to be taken into account.

Promotion strategies cover five main aspects (Kohls and Uhl 2002):

1. **The goal of promotion.** There are three main goals of promotion, namely, to remind, inform or persuade. For a seed company selling field crop seeds which usually have a short selling period once per year, the goal of promotion will be determined by the stage of the crop production cycle. Prior to seed purchasing, there may be more emphasis on reminding and informing farmers of what products are available and what their characteristics are. During the purchase period, information provision and persuasion may be more important to influence purchase decisions. When the crops are growing, and demonstrations and field days are conducted, the objective is information provision.
2. **The theme or appeal of the promotion.** In this instance, the promotion strategy must define what aspect of the product is to be communicated. This relates to the product per se and its distinctive features compared to alternatives. On the one hand, this may simply be the appeal of the price, or attention may be drawn to unique aspects of the product, such as features related to the seed pack, seed quality or value for cultivation and use (see Box 3.3). The theme that is communicated will depend on the goal of the promotion strategy.

3. **The type of promotion.** Promotion may be carried out in various ways, such as mass-media advertising, provision of discounts or loyalty awards, giving of free samples, growing field and road-side demonstrations, holding field days and trade shows, providing merchandising materials, giving sponsorship, and employing sales representatives and customer support services (such as agronomic advice). The use of any of these methods adds costs to the business, but they can be effective in increasing sales, either through lowered prices or increasing consumer decisions to purchase your product in favor of alternatives.
4. **The media of the promotion.** There are many options with respect to the type of media used for promotion, but the selection of the most appropriate one depends to a large extent on the preceding points. The use of community radio stations is an effective means of broadcasting information to a large number of rural farmers, particularly where literacy rates are low. Verbal messages are useful during the seed purchasing period. In cities and villages, the print and visual media (posters, field signage, bus-stop shelter placards, etc.) are effective in conveying headline messages about products and serve as reminders to customers of the company and its products. The use of point-of-sale materials, in-store advertising and merchandising salespeople is aimed at persuading customers to purchase. Personal contact and presentations are particularly useful at field days and discussion groups to provide information about varieties.
5. **The target of the promotion.** With crop seeds, we tend to think of promotion strategies directed at the farmers themselves, and rightly so, for they are the ones who grow the seed. But, in many communities, the farming is done by women who may not be the decision-makers in the households. Furthermore, in situations where there is a significant urban migration, purchasers of seed are often the urban migrants who send the seed back to their rural homes for production. A significant amount of seed is not sold directly by the seed company to the farmer, but through retailers and agents to farmers. Lastly, for some products that have a particular utility characteristic, such as sweet corn or baby corn, the target of promotion may not be so much the farmer but the agro-processor. Consequently, a seed company must determine where promotion activities will have the greatest impact in increasing sales' volumes.

Variety demonstrations and field days

Variety demonstrations are used to display new and current products to farmers with the objective of creating demand for products. Usually, only a few new varieties are demonstrated alongside one or two known and commonly used check varieties on relatively large, unreplicated plots in farmers' fields. Demonstrations of the same set

of varieties may be conducted at many locations, even within the same district. The choice of the locations becomes important for promotion—selecting successful and influential farmers who are strategically located makes for effective demonstrations (see Box 3.6). Labeling of demonstrations with large, clearly legible signage ensures passersby and field day guests can identify the varieties on show.

Box 3.6 Site selection criteria for promotional demonstrations

- Farmer—do other farmers respect and learn from the farmer? Is the farmer keen and willing?
- Management—is the management on the farm good?
- Supportive farmer—is the farmer helpful to others?
- Social issues—can other farmers visit the farm freely?
- Representative farm—does the farm represent the target market in terms of soils, rainfall, etc?
- Visibility—is there sufficient width of frontage, how fast does traffic pass, how frequent are passersby?
- Accessibility—is the location easily accessible for field days?
- Focal point—is the location central to the target market?
- Fresh site—does the location still provide interest to the community?
- Local leadership and extension staff—have community leaders and extension staff been involved in site selection and field day organisation?

Source: B. Nyakanda, personal communication, 2008.

The decision to conduct a field day at a demonstration site depends on the attractiveness and location of the demonstration. Avoid poor crops and only select those crops that have grown well and which will clearly demonstrate the strengths of the new varieties. There is no fixed format for a field day, but key components include presentation of the varieties by company agronomists or sales representatives, general talks of crop management, farmer-evaluation of the varieties, and of course, food and refreshments! Farmers will be attracted to field days if there are give-aways (e.g., hats, T-shirts) and good information provision (e.g., advertising and educational materials). Since agronomic management is an important element of crop productivity, demonstration of improved farming technologies and discussions around farm management, along with the presentations of varieties will help farmers to learn new skills.

Selling seed

Only sales produce income and profit. Without sales, there is no need to produce, carry out research or even continue as a seed business. Selling seed is therefore about actually making those sales that earn income and profit. In the marketing strategy, a seed company will set sales goals for products according to time schedules. The sales team is then responsible for ensuring that sales goals are achieved. Sales goals will be

attained only if the sales team focuses on activities that move the sales process forward with every given or potential customer.

Most sales from a seed company will not be made directly with farmers, but with intermediaries, such as wholesalers and retailers. The sales team will therefore gear its selling technique towards garnering orders from the intermediaries, basing this on the advantages that the intermediary will gain from stocking and selling seed. Intermediaries will not so much be interested in the characteristics of the product *per se,* as with the potential re-sale value of the products to customers and the trading terms that the seed company can provide. Knowing the boundaries of pricing, discounts, credit terms and delivery volumes will enable the sales team to negotiate sales with stockists. Furthermore, provision of promotional materials, merchandising support and point-of-sale information may assist in convincing intermediaries to stock seed.

Since seed of field crops is normally only sold over a short period of the year, the actual selling activity of the sales team will be highly concentrated. Nevertheless, the sales effort does not remain idle during the rest of the year. Well before the selling season begins, potential stockists are visited to scout future sales, inform buyers of the benefits and sales opportunities of seed stocking, and educate store managers on seed storage and handling. Immediately prior to the selling season orders are gathered, trading terms negotiated and seed delivered to ensure stockists have sufficient stocks as soon as farmers begin to demand seed. During the selling season, stockists are visited regularly to monitor stock levels, sales progress, in-store merchandising and need for further supplies. Moving stocks from slow-moving outlets to fast-moving outlets, conducting short-term sales promotion in dwindling or stagnant sales' areas, and dealing with sales transactions will comprise a significant part of the sales team's activities at this time. As the selling season tails off and comes to an end, activities will include organizing stock returns and debt collection. An annual review of sales and stockist performance will provide input for planning future sales goals and activities.

Customer support services and complaints management

Customer support services are required pre- and post-sales. Prior to a sales transaction, support principally involves provision of information to enable the customer to make the best decision concerning variety choice or quantity of seed to purchase. At the point of sale, the customer expects to receive a service that will make the transaction a good experience. Post-sales support may include services such as seed delivery to the customer, provision of planting and management information, follow-up of crop growth and

performance, and handling of complaints. The objective of these services is to maintain and promote long-term mutually beneficial relationships between the customer and the business. The types of services will obviously depend on who the customer is—whether the stockist or farmer.

One of the most difficult but crucial aspects of customer service is complaints management. The way a complaint is handled may determine whether the customer's future purchase is secured or lost, while it may also have a much wider impact through the customer's interactions with other customers. Complaints in the seed business are mostly related to the performance of the seed at germination and emergence, but there are a multitude of other situations that may give rise to complaints, such as in the nature of promotional activities, point-of-sales' service, account management, and product performance relative to expectations and advertising.

The nature of the investigations to a complaint depends on the type of complaint (Table 3.1), but the key to good complaints management is the speed, grace and honesty of response. Ignoring or unfair handling of a complaint is a sure way of causing further discontent. Rather, respond in a prompt and responsible manner, as follows:

- Receive complaints respectfully and focus on finding a solution to the complaint and not on defending oneself to the complainant;
- Gather and record all relevant information, sifting out the important from the irrelevant, the factual from the fictitious, the objective from the subjective;
- Recover, where appropriate, transaction documentation, seed packaging and seed labels; and
- Carry out investigations with integrity and honesty.
- Feed-back findings to the complainant with honesty, humility and solutions.

Table 3.1 Common seed-related complaints and the key issues to investigate in determining the cause and nature of the problem.

Complaint	Key issues to investigate
Dissatisfaction with sales transaction	• Questions of who, where and when related to the transaction • Inter-personal clash or transaction errors or both?
Dissatisfaction with account management	• Questions of who, where and when related to the transaction • Transaction details • Credit terms and Interest calculations
Seed packaging breakages	• Where and when was the seed purchased? • How was the seed handled? • When and how was the seed packed? • What is the lot number?
Weevils and storage pests in seed bags	• Where and when was the seed purchased? • What have been the storage conditions? • Was the seed treated for storage pests? • What is the lot number?
Excessive seed defects (cracks, insect damage, poor seed treatment)	• Where and when was the seed purchased? • When was the seed processed? • What is the lot number? • How has the seed been stored and handled?
Poor germination	• Where and when was the seed purchased? • When was the seed processed? • What is the seed lot number? • Where and how was the seed stored? • What were the conditions like at sowing?
Unexpected agronomic performance	• What is the seed lot number? • Where and when was the seed purchased? • What agronomic management practices have been applied to the crop (planting date, fertilizer, herbicides and pesticides)? • What have the weather conditions been like (rainfall and temperatures)? • Have there been any unusual pest or disease outbreaks?
Variety not true to type	• What is the seed lot number? • Where and when was the seed purchased? • Who produced the seed and what do the inspection reports indicate concerning certification? • Where and when was the seed processed? • How was the seed stored on the farm? • Was the seed in the original company packaging at purchase and planting? • Was there any possibility of seed admixture after purchase and before planting?

Once all the relevant information about a complaint has been gathered, determine the real cause of the complaint and where the true fault lies. Even if the fault is found to be with the customer (for example, poor on-farm storage) or with the weather (say, lack of rain at planting), use this as a means of educating the customer. Where the fault lies with the seed company, ensure that the blame is honestly borne and restitution provided to restore the customer's confidence in the company. The cost of restitution is often far less than the cost of failing to deal with a complaint fairly. View complaints as a means of improving your service and seed quality, and as a way of maintaining good customer relations. Do not consider complaints as unnecessary and confrontational interaction with a customer.

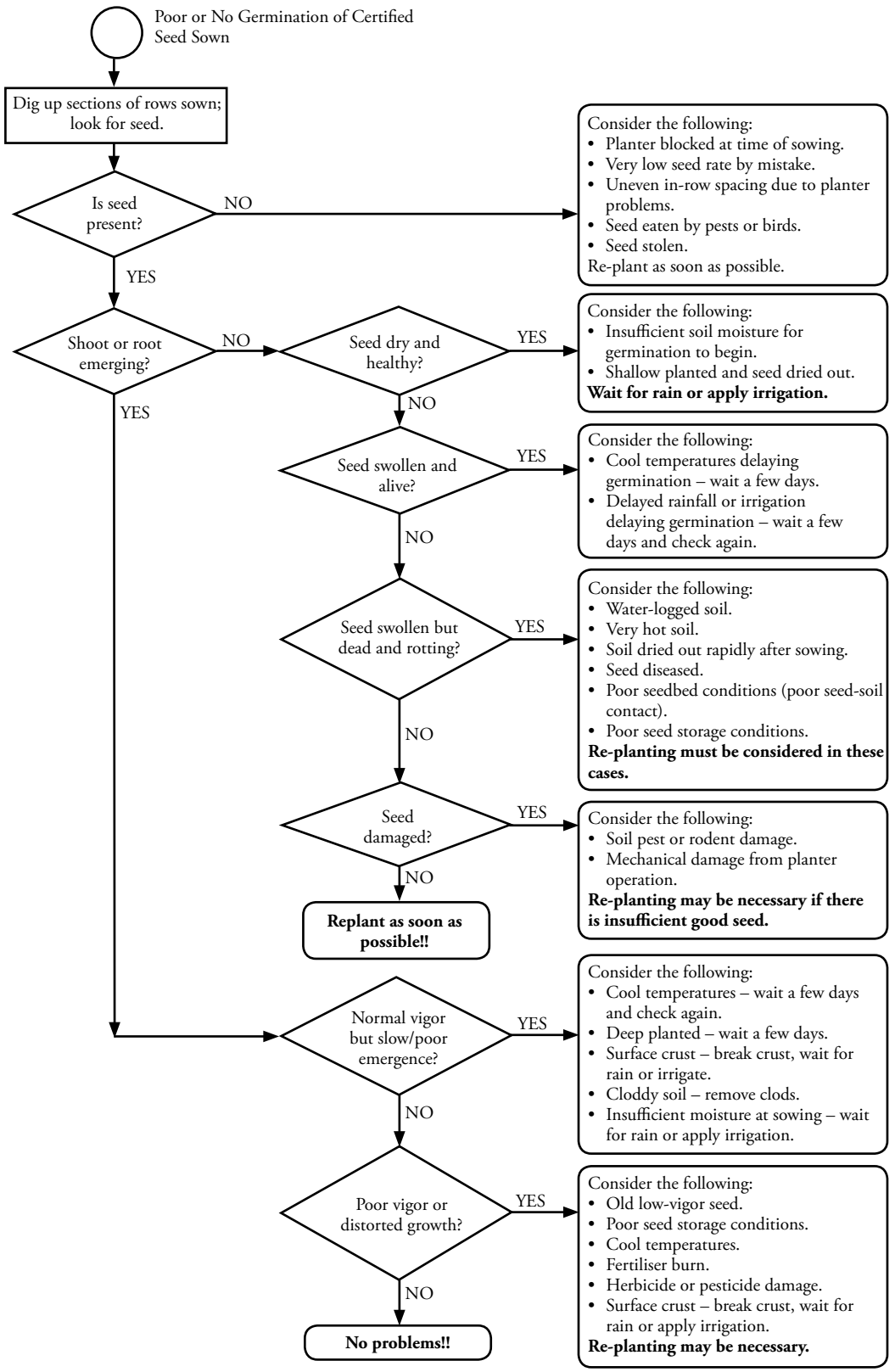
It is useful to have a "Complaints Registration Form" to assist in the investigation of complaints and a "Complaints Registry" to log and evaluate the frequency and nature of complaints (Appendices 1 and 2). As complaints are received and logged into the Complaints Registry, a pattern may emerge that informs management of problems in quality assurance at particular stages of the seed chain. These may then be rectified. This also provides an objective measure of how the company is performing with respect to seed quality in the longer term and the cost this has on the business.

With respect to germination problems, it is rare that the cause of poor germination is the seed itself (provided, of course, that seed quality is assured). Generally, upon investigation of in-store or on-farm seed storage, or planting conditions and rainfall patterns, it is often found that conditions for maintenance of seed viability and good germination were less than ideal (see Box 3.7), but this is no reason to dismiss germination complaints as simply being the fault of the farmer. Germination complaints may serve as a useful way of interacting and educating farmers on planting methods, while replacing seed, even when the fault was not with the seed, is a small cost in comparison to the goodwill and valued assistance given to the farmer.

Seed distribution

Seed is living, delicate and bulky, and usually only sold during a short period of the year. Consequently, the system of moving seed from the warehouse to the market must be conducive to the maintenance of seed viability, while also meeting the customers' requirements for timely and sufficient supplies. Although a seed company may sell seed directly to the farmer from its own warehouse, it is usual for most seed to be channeled to widely distributed farmers through intermediaries, such as wholesalers, retailers and agents. Selecting appropriate market channels is therefore important to a successful marketing strategy.

Box 3.7 Field emergence diagnostic guide



Wholesalers or seed depots are those businesses that will sell most of their seed (and other products) to other businesses (retailers) or organizations, rather than directly to the farmer. Retailers will sell the majority of their seed and other products to farmers. A seed company with a dispersed target market may find that the appointment of a number of strategically located wholesalers will help to give rural retailers easier access to seed supplies for onward sale to farmers (Figure 3.6). Retailers may include agents, seed stockists, agro-dealers, agro-processors, supermarkets, kiosks and the like.

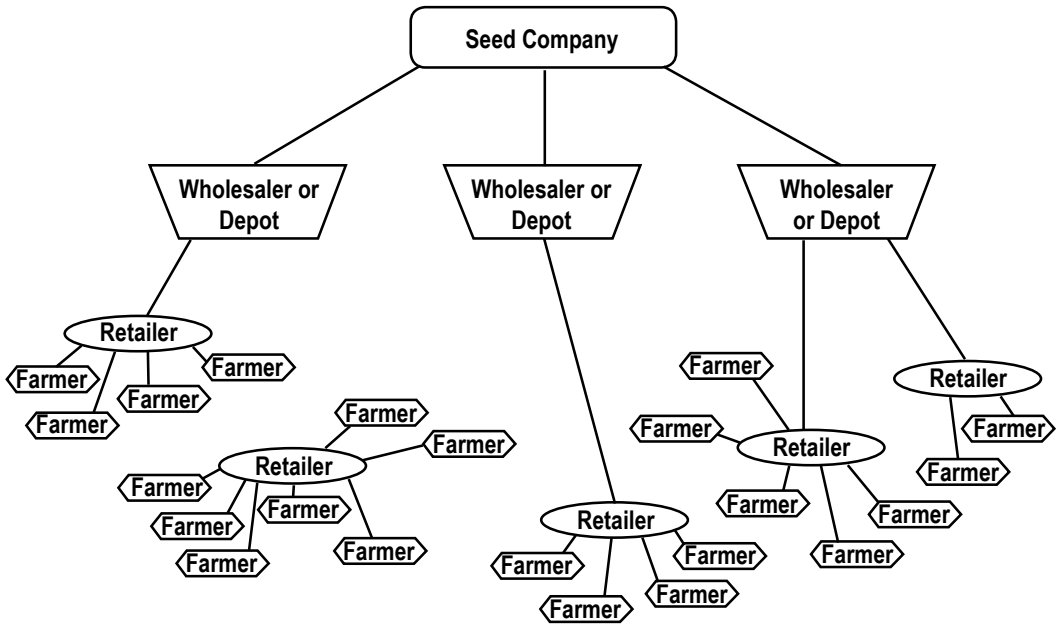


Figure 3.6 Schematic representation of the flow of seed from a seed company to farmers through intermediaries.

The support given and trading terms offered to each of the intermediaries will depend on the volume of seed sold and credit worthiness of the customer. Generally, wholesalers receive 30- to 90-day credit for stocking seed, while retailers and farmers pay cash, sometimes with quantity discounts. In some instances, wholesalers or retailers may be given seed on consignment basis, but this is more risky and difficult to manage. Seed companies usually employ sales representatives to manage orders and transactions with wholesalers, and to promote seed stocking amongst retailers. The provision of point-of-sale advertising and in-store merchandisers promotes customer awareness and sales. Furthermore, training of shop managers and sales' staff in seed storage and product characteristics helps ensure seed viability and sales, respectively.

Dealing with Governments and NGOs

Governments and NGOs may be significant seed purchasers in some markets. The principal advantage of these intermediaries is that they tend to purchase large quantities of seed, thereby eliminating the need to establish and maintain a wholesaler or retailer network. Distribution through government and NGO seed schemes also present a means of extending and promoting a seed company's products without significant expenditure on sales promotion. However, the disadvantages are that they are not always consistent or predictable in their quantity requirements, for their demands are often related to disaster relief or political seed hand-outs. The process of seed procurement is usually through unpredictable tender systems; they may require odd-sized or unique packaging. Additionally, delivery schedules may be demanding and payment terms may not be ideal.

Key aspects to managing government and NGO orders include:

- Engage authorities, donors and NGOs to engender understanding of the seed sector.
- Provide information on product availability, seed prices and variety characteristics.
- Lobby for advance orders to assist in seed production planning.
- Promote the involvement of the retail sector in seed distribution through voucher schemes.
- Encourage appropriate variety distribution according to mega-environments and farmer requirements.
- Uphold seed certification standards, variety registration procedures and good packaging standards to avoid infusion of fake-seed and unscrupulous traders.
- Follow-up seed distributions and relief-schemes with company representations, demonstrations and field days to promote future sales opportunities with the farmers who receive the seed relief.

Marketing seed in foreign territories

Seed sales may be increased by exporting seed to foreign countries. When evaluating the potential of an export market, consider the following points:

- **Regulatory issues.** Are you able to sell your varieties in the foreign country? In most African states, it is necessary to first register a variety in a country before seed of the variety may be sold. Registration procedures are lengthy and costly, and therefore the investment required must be judged against the expected future returns.
- **Business strategy.** How and with whom shall the seed be sold? Export markets may be either governmental organization (GO) and NGO-seed relief related, or as

a means of establishing a long-term business in a foreign country. The foreign GO and NGO markets are usually short-term opportunities that result from natural disasters, but they may lead into longer-term business development prospects. If the foreign market is viewed principally as a long-term business development, then a large amount of strategic planning should be done concerning establishment, partnership development, seed production programs and marketing.

- **Seed import procedures.** Does the seed intended for import-export meet the import-export requirements? The documentary requirement for export of seed begins with the receipt of an import permit from the foreign country. This will specify the conditions that must be met for import of seed, which usually include an export permit, phytosanitary certificate, OECD seed certification certificate, an ISTA Orange International Certificate, a Commercial Invoice, a Central Bank clearance certificate and shipping documents. To obtain these numerous documents requires advanced planning and organization.
- **Payment for seed.** How will the transaction take place? Normally, products may not be exported from a country without advance payments or international credit guarantees. Thus, seed exports must be based on firm orders and assured payment.
- **Shipment method.** How will the seed be transported to the destination? Cross-border or over-sea transport systems are often slow and expose seed to unfavorable weather conditions that may reduce seed viability. Air freight is normally cost prohibitive except for small quantities of high-value seed. Consequently, it is necessary to establish the best method to transport seed that will ensure maintenance of seed viability and quality.

Understanding and competing with the competition

In business, competition is a fact of life. Almost all businesses have competition, and this is a reality in the seed sector. Not only do seed companies face competition from farm-saved seed, but with the growth in the number of seed companies in Africa, inter-company competition will increase. In order to survive, a business must learn about the competition it faces and implement ethical measures to compete with the competition.

Understanding the competition

The seed market is constantly changing, both in terms of suppliers of seed and the nature of the seed being supplied. Thus, it is necessary to identify the various sources of competition and their characteristics. Competition may come from:

- **Illegal imports,** particularly where local seed supplies are inadequate or costly and cross-border supplies are adequate or cheaper. Borders in Africa tend to be rather porous, especially in times of scarcity, and unscrupulous traders may attempt to supply seed into markets without following correct procedures. Such seed may or may not be of a suitable variety or assured quality. Government intervention is most helpful in combating illegal imports of seed.
- **Legal imports** may be a threat when there is a seed price or quality differential with local supplies. Such imports are usually quality seed of appropriate varieties.
- **Large multi-national businesses** with great capacity for seed provision or which have technologically advanced genetics.
- **Small local businesses** which may be aggressive or have low operating expenses, who are seeking to penetrate markets.
- **Fake seed** sold by unscrupulous traders. This seed is usually derived from grain, and may be sold in forged packaging. This is a most pernicious form of competition in the seed sector, as it not only undermines the quality assured formal sector but disadvantages farmers by providing poorly performing products. Government support to eliminate this form of competition is necessary.
- **Farm-saved seed** is particularly a factor of competition with self- or open-pollinated crops. The most dangerous competitors are emerging businesses who are attempting to gain market share through aggressive selling techniques or provision of unique technologies or both.

To gain an understanding of the competition requires gathering intelligence related to the marketing strategies, strengths and weaknesses, product characteristics and production volumes of competitors. Such information will never be complete or infallible, but should at least give an impression of the threats that are faced, and the position of your company in the matrix of the seed sector (Figure 3.7). In each market there is a total seed demand, met by some proportion of purchased seed (including seed relief and distribution programs), farm-saved seed (which may also include fake seed) and seed imports. Within the proportion of seed planted to purchased-seed derived from the formal seed sector, a number of companies may be competing with one another, with farm-saved seed and with seed imports. The proportion planted to purchased-seed will shrink or expand depending on the combined efforts of the formal sector to produce and market certified seed, the relative cost of certified seed to farm-saved seed, and macro-agricultural economics and policies.

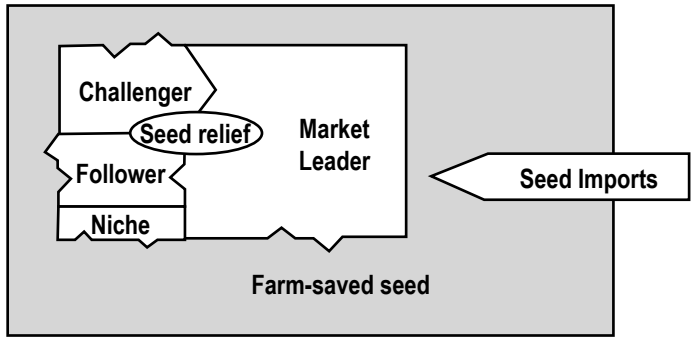


Figure 3.7 The seed market is composed of all the seed planted by farmers.
Note: This seed nay be derived from farm-saved seed (including informal seed trade), seed imports and the formal sector. Seed relief schemes, if they exist, mostly obtain seed from the formal sector or seed imports. If there is more than one seed company in the formal sector, they may be characterized as either market leaders, challengers, followers or niche players. The market share of each may grow or shrink relative to each other and the amount of farm-saved seed used by farmers.

Within the formal sector, there may be a market leader, who has the largest market share. Other seed companies may be identified as challengers, who are encroaching on the market share of the market leader or expanding seed sales to approach or exceed the quantity sold by the market leader; Followers, who are maintaining or losing their market share or are faced with declining sales, and pose little threat to the leader or challengers; and niche competitors, who are providing seed to particular markets not serviced by other companies. The competitive strategies of each type of competitor will depend on their position in the market. Leaders tend to be defensive, challengers aggressive, and followers passive. However, as noted previously, the proportion of farmers in Africa using improved seed is generally very low, and therefore the level of competition between companies in such a market is less than the competition faced from farm-saved seed and the informal seed sector. Consequently, seed companies should focus more on expanding the market with provision of improved seed than attempting to encroach on the market share of other companies.

Competing with the competition

The majority of seed businesses know that they have to do more than hope that sales will improve. Seed businesses must realize that rather than wait for change, they must have an active approach to maintain present market share and increase seed sales, especially amongst farmers who do not presently use improved certified seed.

"Poor firms ignore their competitors; average firms copy their competitors; winning firms lead their competitors"
Philip Kotler

In determining strategies for competing with the competition, it is necessary to establish why customers buy from competitors rather than from your company. Factors to consider include:

- Price. Customers always want a "good buy" and so will always compare the price (value) of certified seed with that of alternatives.
- Quality. Customers want products that present and perform to their expectations. Therefore, consider how the quality of seed compares with competitor seed.
- Ease of access. Customers generally prefer to buy from the most convenient place. Is the distribution strategy designed to locate seed in accessible places?
- Appropriateness and adaptation of varieties. Farmers need seed that will suit their requirements. If a company's product portfolio is inadequate, it will be necessary to find new varieties that will be preferred to the competitor products.
- Advertising. Farmers often lack information about crop varieties, their characteristics and areas of adaptation. Farmers are also not very familiar with variety names. Advertising and information provision therefore helps customers know about products. Naming products with local and memorable names helps farmers to remember and recognize varieties amongst competitor products.
- Service. Customers may prefer to buy from seed businesses that offer agronomic services, and good back-up if they encounter problems.

The competitive strategy of a seed company will depend on its position in the market. As a market leader, defensive strategies will dominate. These will employ brand strengthening tactics, seek ways to expand the total market size, and use promotion to attract new purchasers of products. Challengers in the seed market will use strategies to increase the total market size and gain market share from market leaders and followers. Such strategies may include competitive pricing policies, product innovation, distribution innovation, improved service provision, brand building and intensive advertising. Market followers tend to imitate, emulate and adapt the strategies of market leaders to their own products and services, with some improvements or variations. Seed companies pursuing niche markets seek out geographic or customer niches, develop unique end-user-oriented products or provide products with speciality traits for particular markets. Marketing strategies will also tend to be very targeted and personal.

Ultimately, each company will seek to be differentiated in the market through product innovation, distinctive branding and value provision, while maintaining viability and sustainability through cost management, competitive pricing and pursuit of sales volume growth. Successful seed companies will satisfy customers better than their competitors, and consequently grow and prosper while others stagnate and fail. Furthermore, competitive activity in the seed industry will lead to the provision of a greater selection

of improved varieties to farmers, enable farmers to produce a wide range of products for the commodity and industrial markets, and contribute to the increase of the agricultural economy of a nation.

Key thoughts

1. The marketing strategy of a seed company is concerned primarily with meeting the seed product needs of customers and competing with the competition.
2. The products that a seed company sells will determine the customers to which it may sell its products. If a seed company intends to expand its market, this may only be possible if the products available are needed by potential customers.
3. The customers that a company intends to sell seed to determine the nature of the product that must be supplied. Seed companies must therefore understand the product needs of its customers and implement product development to obtain the desired products.
4. The product that a seed company sells is not simply the seed, but includes many tangible and intangible aspects related to the seed, such as the genetic potential of the variety, the quality of the seed, the seed packaging and services that are supplied with the seed.
5. Seed pricing is a complex procedure that considers internal and external factors. The price of seed of a variety is always relative to farm-saved seed and seed of competitive or alternative products. Internally, a seed company must set the price of seed to ensure a sufficient gross margin to cover operational costs and provide sufficient profit for sustainability and growth.
6. Promotion of products is about effective communication of the key attributes of a variety and the services provided by the company. The goal of promotion, together with the theme, type and media of promotion must be considered in all advertising campaigns.
7. Selling seed earns the company income and is a means of providing profit. Active selling, particularly with intermediaries such as wholesalers and retailers, will ensure that farmers have access to seed.
8. Seed companies will face customer complaints. These, while often uncomfortable experiences, may be good learning experiences and a means of engendering customer loyalty if dealt with graciously and professionally.
9. Competing with the competition begins by knowing and understanding the characteristics of the competition. Only then can a strategy be developed to compete. To out-compete competitors, focus on product characteristics that are required by customers and on quality of service.

4

Research and Development for Appropriate and Adapted Products

Successful seed companies are not oblivious of the market requirements and so they seek to continually provide improved products to maintain and grow market share. Thus, a seed company needs a product development strategy to guide the identification, registration, promotion and scale-up of appropriate products. The product development process begins with breeding, where genetic variation is created in order to allow for selection of desirable plant types. The selection process screens for those traits (observable plant characteristics) that are required by the market. This involves various methods of testing the new plant types relative to existing popularly grown varieties, so that only those that are better are maintained and advanced. When sufficient testing has been conducted to give an acceptable measure of confidence that the new variety is better than the existing variety and will meet the market requirements, and can be reliably produced in a cost effective manner, the new product may be launched onto the market. Typically, the time taken to breed, select, and launch a new variety ranges from eight to 15 years, and consequently this is an expensive and long-term venture.

The scope and content of a product development strategy depends to a large degree on the situation of the seed company with respect to sales volume (or more precisely, sales value and profitability) and the level of market specialization (Figure 4.1). The sales volume and seed price determines turnover and consequently the amount of funds available for product development activities. Thus, a small seed company with a low volume of sales will have few resources to expend on a fully functional product development program. Such a company will therefore depend much on public germplasm available from National and International Agricultural Research Centers. But, public germplasm is not only useful to small seed companies. Whatever the scale of a company's operations, value may be extracted from public germplasm, provided it is useful in the market.

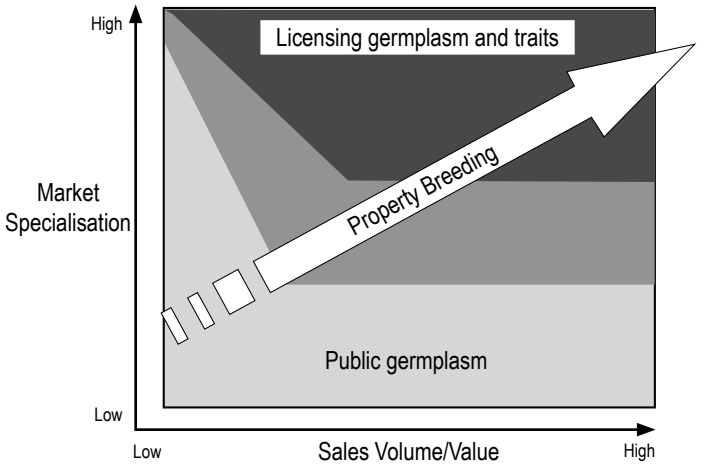


Figure 4.1 A schematic representation of the scope and components of a product development strategy of a seed company relative to sales volume/value and market specialization.

Note: Public germplasm is of potential use in the full range of situations; while proprietary breeding and the licensing of germplasm and traits may be more necessary as turnover (profitability) and market specialization increases, as indicated in the diagram by darker shades of grey.

Seed companies exist in the context of a market scenario. A market targeted by a seed company may be more or less sophisticated or specialized. Some farmers may demand high-performing single-cross hybrids with special traits, while others may only require open-pollinated varieties because their production environment is risky or they do not have the sufficient resources to achieve high yields. Where a company is providing products to a less specialized market, public germplasm may be the best source of improved varieties. However, as market specialization increases and farmers become more discerning and demanding, a seed company may find it necessary to enter into licensing agreements with commercial germplasm providers if public germplasm does not supply appropriate products. This may be the case for particular traits, such as yellow maize, sweetcorn, popcorn and waxy maize, or in certain crops where there are no public germplasm sources, such as cotton, soyabeans, and hybrid sorghum and vegetables.

With the advent of genetically modified organisms (GMOs), licensing of germplasm and traits has become commonplace in markets where GMOs are useable. Currently in sub-Saharan Africa, GMOs are only commercially available in South Africa, where insect- and herbicide-resistant maize, soyabeans and cotton are marketed. These genetically modified traits are only available from a few multi-national companies, but other local seed companies have been able to license the traits and incorporate them into their own germplasm for marketing. These licensing agreements usually carry royalty, biosafety and stewardship clauses. Biosafety regulations exist in Zimbabwe and Kenya and are being

developed in most other African countries. Some regulated and government-approved testing of GMO maize has been carried out in Zimbabwe and Kenya, but at the time of publication, no commercial GMOs have yet been registered. This is an aspect of the seed sector that may bring about rapid change in product development and marketing in the near future if GMOs become accepted in more countries in Africa.

Although public germplasm and licensing agreements may provide useful and inexpensive sources of varieties and traits, a seed company may still consider the possibility of establishing proprietary breeding activities. The decision to conduct a proprietary breeding program is a function of at least three things:

1. Turnover of the company. As mentioned, research is an expensive activity. Seed companies that have proprietary breeding activities generally spend in the order of 3%–10% of their turnover on research. Thus, turnover has to be significant to provide sufficient funds for an adequate and sustained breeding program.
2. Availability and suitability of public and licensable germplasm for the target market. To a large degree, public germplasm will be a good source of "ready-made" products, while there may also be good sources of useful varieties from other seed companies on a royalty-basis. However, there may be cases where the only way to develop appropriate germplasm is through proprietary breeding. Nevertheless, the decision to enter into a breeding program should only be made after thoroughly reviewing the suitability of other sources of germplasm.
3. Market scenario. As a market becomes more differentiated and competitive, a seed company may have to develop more unique products, which may require a proprietary breeding program. Nevertheless, even with a proprietary breeding program, public and license-bearing germplasm may be of great use in developing and launching appropriate varieties.

Whether a seed company maintains a proprietary breeding program or not does not negate the need for variety testing and selection. Thus, a seed company, whatever its size, needs to have a strategy for product development. Whether the source of improved varieties is from public, licensed or proprietary products, such varieties need to be evaluated against internal and external check varieties. This requires trials that are sufficient in number, located in environments where they will be marketed and be of adequate quality to enable objective evaluation of performance and acceptability. The closer a product moves towards market launch, the greater must be the participation of farmers and end-users in the selection process. One of the greatest causes for the failure of market penetration of a new product is the launch of an inappropriate variety due to the inadequacy of testing and evaluation by farmers and end-users.

As a seed company grows in turnover and profitability, the amount of money spent on research will, or at least should, increase. A case in point is that of Pioneer in the USA (Figure 4.2). The company began in the early 1920s and for the first 25 years or so spent relatively small amounts on research because the market was mostly based on open-pollinated varieties and farmers were not using advanced agronomic practices. In the 1950s and 1960s, the use of hybrids and fertilizer by farmers began to increase, and so the amount spent on research also began to increase in order to test and select improved products required by the market. However, the company still relied heavily on well-funded and prolific public germplasm providers. Significant changes occurred from 1970 onwards. First, legislation was introduced to give plant variety protection to proprietary breeding programs; second, the competition amongst seed companies increased as farmers became more demanding of high-performing products; and third, the value of seed sales increased enabling more resources to be applied to research. A more recent development has been the emphasis on genetic modification for insect and herbicide resistance. Consequently, today, Pioneer is highly dependent on a proprietary research and development strategy. Their research investments continue to grow and in 2009 were much higher then they were 1999.

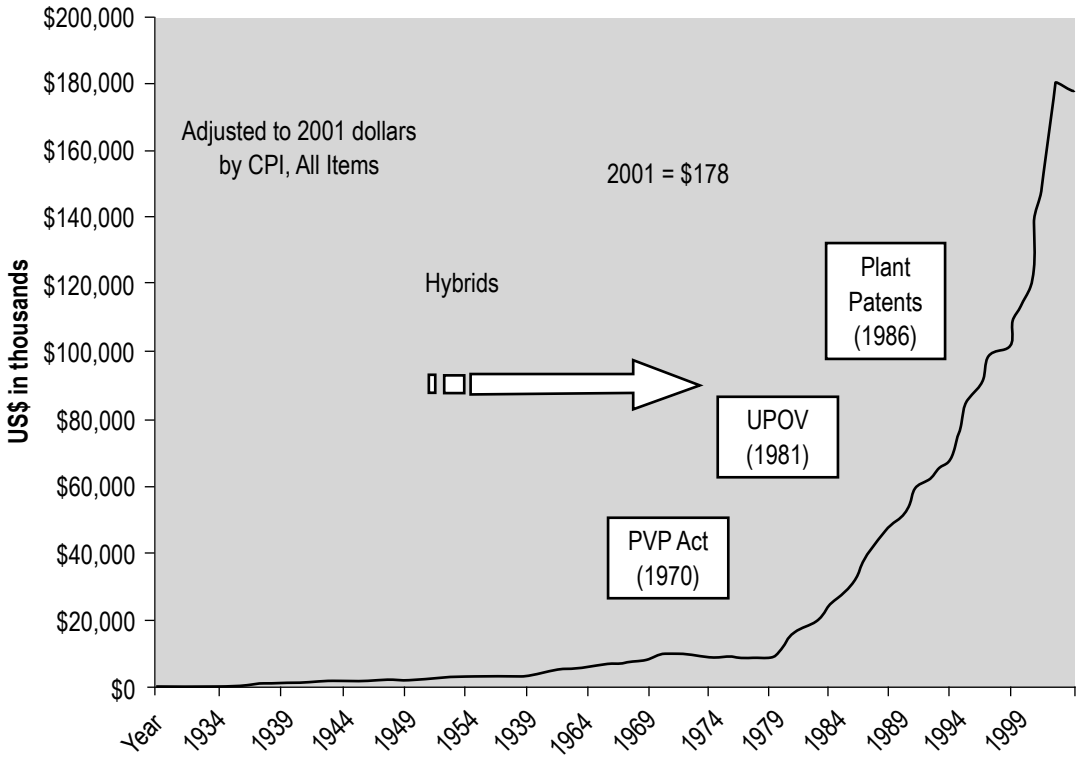


Figure 4.2 Total maize research investment by Crop Genetics Research of Pioneer, USA.

Source: Stephen Smith (Pioneer) and Vernon Gracen (Cornell University), 2008. Used with permission.

Planning and management strategies for product development

Since the product development process is a costly and time-consuming exercise, a seed company must orientate and manage the process in a manner that ensures that appropriate and adapted varieties are launched onto the market. In order to develop the right products, a company needs to identify the target market segment and the requirement(s) of the market in that segment (Figure 4.3). This will determine the right issues that need to be worked on by the research department. In other words, this defines the product development objectives. In order to reach these objectives, the right tools must be employed in an efficient manner.

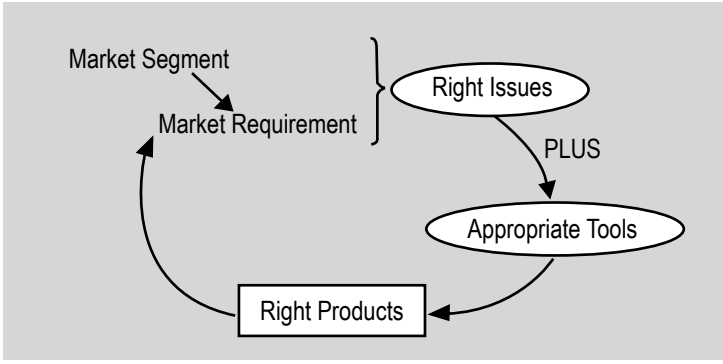


Figure 4.3 Schematic diagram of the process of orienting a research strategy.
Note: The market segment and requirements determine the right issues or goals for research. Together with the application of appropriate tools, products will be developed that will meet the market requirement.

While developing the research strategy for a seed company, two aspects need to be reviewed (Figure 4.4). The first is the relevance of the research. Here, the question is, "Are we working on the right issues?" The second is the efficiency of the research, where one asks, "Are we using the right tools efficiently?" The answer to these two questions will determine what needs to be done in the research activities in order to be more effective in producing the right products for launching onto the target market.

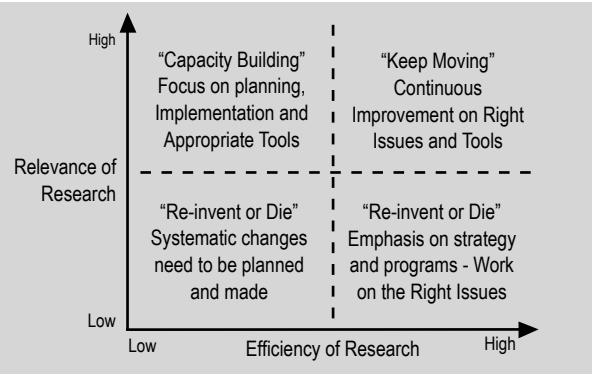


Figure 4.4 Planning and management strategies for research as a function of the relevance and efficiency of activities.

Note: Adapted from W. Janssen (2001).

In the worst case of a research department working on issues of low relevance to the market in an inefficient manner, the seed company needs to re-invent its product development strategy or risk losing market share. Systematic and even drastic changes will need to be planned and made. The strategy must identify the market requirements and research activities will need to be revamped. Where a company has highly relevant research; in other words, the right issues are being addressed; but the efficiency is low, then a capacity-building strategy needs to be employed so that the right tools are implemented in a more focused and efficient manner. On the other hand, a company may find that the research activities are efficient; in other words, many new varieties are being produced regularly at reasonable cost; however, the relevance of the research may be low and the products unsuitable for the target market. In this case, the strategy requires re-orientation, with emphasis on identifying the right issues and goals. Finally, if a seed company's research is both relevant and efficient, then the strategy is to keep the pipeline flowing as effectively as possible.

Identifying the right issues for the target market

Africa is a vast continent in which the various combinations of climate, soils and altitude determine crop suitability and potential. Even within particular countries, the bio-physical environment is highly variable. This variation, however, does exhibit patterns when defined by altitude, average air temperature and annual rainfall. With respect to maize, six mega-environments have been defined (Figure 4.5), which offers a starting

point for identifying the right issues for variety development. Maize varieties developed for the dry lowlands are unlikely to be suitable for other mega-environments, and so on. Furthermore, these mega-environments cross national boundaries, therefore developing a variety in one locale of a mega-environment should enable transfer of the variety into other locales of the same mega-environment.

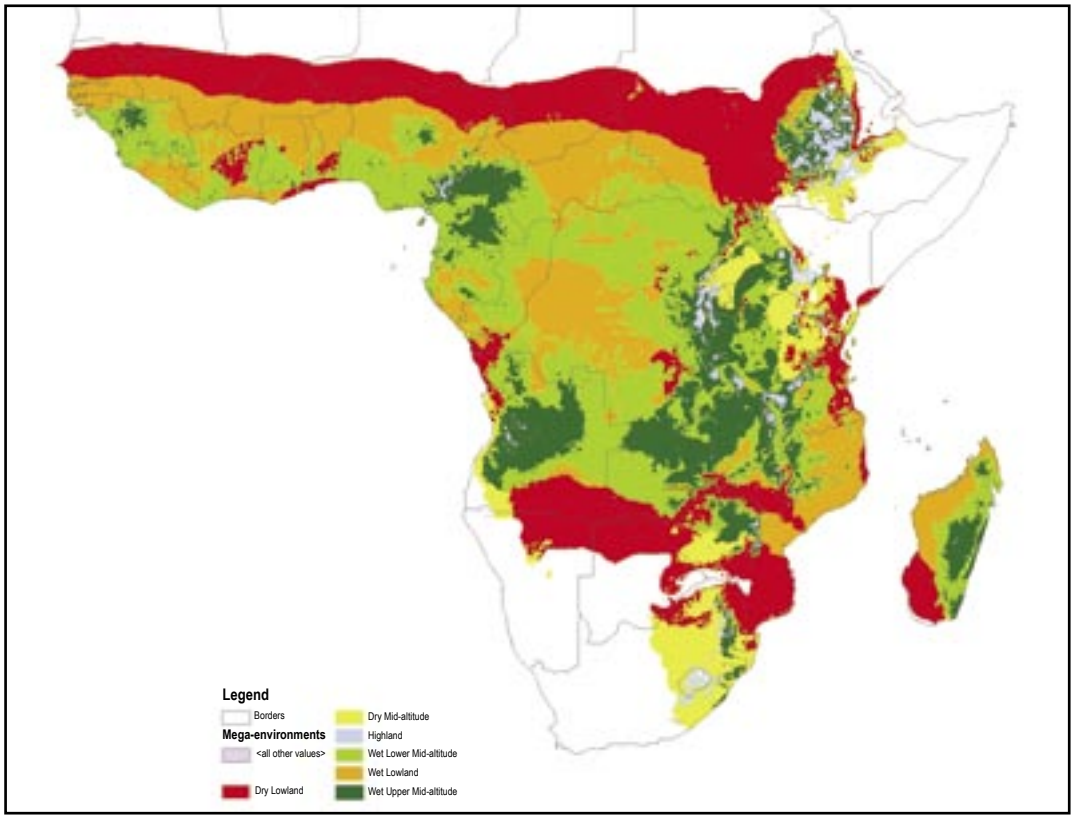


Figure 4.5 Criteria used to define CIMMYT's maize mega-environments at the global level.

Source: P. Setimela et al (2005).

Within each mega-environment, maize is subject to particular biotic and abiotic threats and stresses (Table 4.1). These determine the kind of defensive traits that a maize variety would require in order to grow and yield. Drought is a particularly severe threat in the dry lowlands and dry mid-altitudes, but even in the humid mid-altitudes, mid-season or late-season droughts may occur. Consequently, drought tolerance is a trait that is of relevance to all variety development strategies. Disease threats, like pests, are much related to mega-environments, but conventional breeding for disease resistance is relatively easier than for pest resistance or tolerance.

Table 4.1 Major abiotic and biotic stresses and threats to maize in the six mega-environments of Africa.

			Abiotic Stress			Diseases									Pests				
	Africa	Need for earlier germplasm	Low N	Drought	Low pH	MSV	E. turc	GLS	P. sorghi	PLS	P. polisora	H. maydis	DMR	Ear rots	Striga	Chilo partellis	Busseola fusca	Prostephanus	Sitophilus spp
	Highlands	2.0	2.8	4.3	3.0	3.5	1.0	1.3	1.3	1.3	4.3	5.0	5.0	1.8	4.0	4.5	1.5	3.8	3.0
	Upper humid mid-altitudes	3.0	2.0	3.8	2.8	2.3	1.0	1.0	2.3	1.3	4.3	4.8	5.0	1.0	3.0	3.5	1.5	2.0	1.8
	Lower humid mid-altitudes	3.0	1.3	2.3	4.0	2.5	2.3	2.5	2.8	3.0	3.5	3.8	4.3	2.8	2.3	3.3	2.8	1.3	1.8
	Dry mid-altitudes	1.3	1.0	1.0	4.3	3.5	4.5	4.3	4.0	5.0	4.5	4.3	5.0	3.3	3.8	2.8	3.8	2.5	3.0
	Humid lowlands	3.0	2.3	3.3	3.0	2.0	4.5	4.8	4.8	5.0	2.5	1.8	2.0	2.3	2.3	1.0	5.0	1.0	1.8
	Dry lowlands	1.0	1.5	1.0	5.0	1.8	4.5	4.8	4.3	4.8	3.8	2.8	3.0	3.5	2.3	1.3	4.8	2.0	2.5

Note: Numbers in cells indicate severity of stress or threat, with 1 = high and 5 = low. Likewise, the color code indicates the severity of stress or threat, with red and pink = high, yellow = moderate and blue = low.

Having determined the main mega-environments of the target market, together with the identification of the major abiotic and biotic stresses and threats that need to be mitigated against, the customers' needs must be established. Although most farmers in Africa are direct consumers of their crop produce, a proportion of grain production is also consumed by third-parties, the magnitude of which varies from country to country. In the first instance, when considering the farmer alone, two aspects are of importance—the type of variety needed, and the desired grain qualities.

Maize varieties may be open-pollinated or various kinds of hybrids. On average, improved open-pollinated varieties yield 82% of improved three-way hybrids, and their use is therefore only appropriate where farmer yield levels are less than 2 t/ha (Pixley and Bänziger 2004). As farmers' yield potential increases due to improved environment or management, hybrids will normally prove to be a better option. In drought-prone areas, double-cross and three-way hybrids might be considered to be more stable due to more variable flowering patterns. In highly productive and well-managed situations, single-cross hybrids will consistently out-perform other hybrid types. Single-cross hybrids may also exhibit excellent drought tolerance, stable yields and provide farmers with other useful traits. Additional factors relevant to the type of variety include plant height, lodging resistance, days to maturity and grain dry-down rate. These required traits must be defined by the target market.

With respect to grain qualities, the consumers' preferences become more relevant. Such features as grain color, grain texture, milling or pounding characteristics, protein quality, starch content, oil content, and roasting or boiling characteristics are important in different markets. Maize has a multitude of uses, and although African farmers are primarily concerned with grain for food, other market opportunities may exist for seed companies to exploit, such as yellow maize for poultry production, quality protein maize for backyard swine feeding, silage maize for dairy farmers, sweetcorn for the vegetable market and waxy corn for snack foods and starch production.

Farmers are highly conscious of the yields they obtain from their crops. Likewise, they notice things like standability, ease of harvest, taste of the grain-flour, and storability. They also have long memories of variety performance, notably, poor performance! Thus, farmers appreciate stable variety performance, particularly in the face of the environmental stresses they experience. They are also interested in making a profit, even if this is measured in terms of having sufficient food to see them through to the next harvest. All this indicates the necessity of providing widely adapted and stable products to the market. Farmers will buy the varieties they want, and so it is critical for a seed company to clearly identify what characteristics of the products farmers want.

Employing appropriate tools to efficiently obtain desired products

A product development strategy essentially comprises two major components: breeding (or germplasm development) and testing. However, these do not exist in isolation of one another or of other components of the product pipeline (Figure 4.6). Breeding produces new varieties, which are tested to evaluate performance against product development goals. Concurrently with advanced testing, varieties, especially hybrid varieties, need to be evaluated for seed production viability. Only once a variety is improved, adapted and appropriate for the market, and if it may be viably produced, should it be promoted for release. Those varieties that are promoted are entered into registration procedures, released, demonstrated and launched onto the market. In this pipeline there may be four distinct but inter-related teams: the breeding team, the product development and advancement team, the seed production research team, and the marketing and agronomic services team. Whether or not all these teams exist in a seed company is a matter of size and capacity but in essence, all components will need to be functional, either within or external to the company, if a continual supply of improved varieties is to be made available to the market.

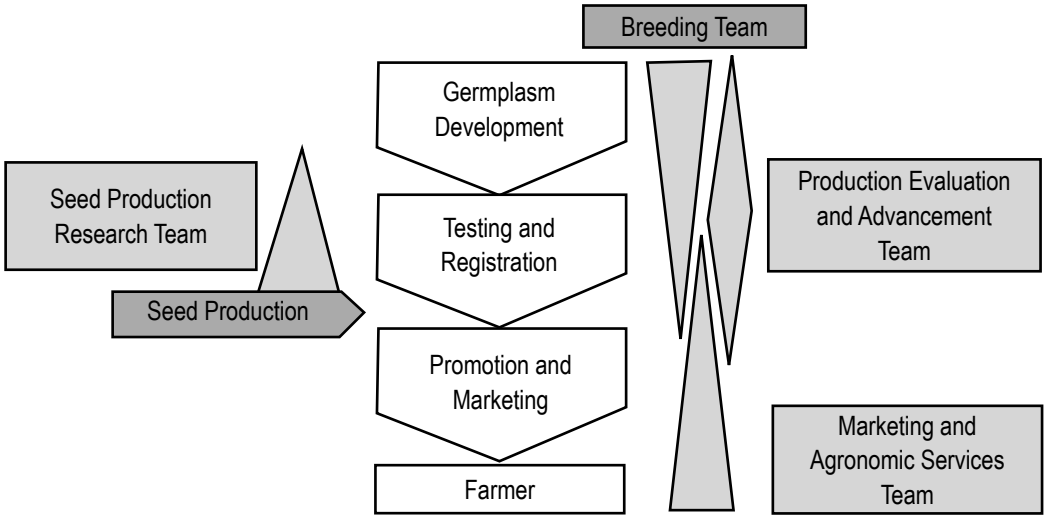


Figure 4.6 The main components of a product development pipeline and the four main teams required to ensure a continual supply of improved products to the market.

Plant breeding progress

Plant breeding is a process of creating genetic diversity and selecting desired genotypes from the diversity. In maize, whether the objective is to produce open-pollinated varieties (OPVs) or hybrids, the general approach is to use pedigree breeding to derive inbred lines that are crossed to form new varieties (Figure 4.7). Germplasm is collected from legitimate public or private sources, and this is either used per se or combined with other sources through crossing, and the F1 plants self-pollinated to create variable F2 populations. Over a series of reproductive cycles of self-pollination, the plants become progressively inbred (i.e., homozygous or true-breeding). Selection is made amongst these plants at each generation for per se performance, and desirable families and/or plants are test crossed to selected parents. The hybrids of these test crosses are evaluated in field trials in environments that are typical of the target market, and superior lines and hybrids are selected for advancement. After five to seven generations, elite lines and hybrids are identified for more extensive testing. Of these, a few will be chosen for variety registration and market release.

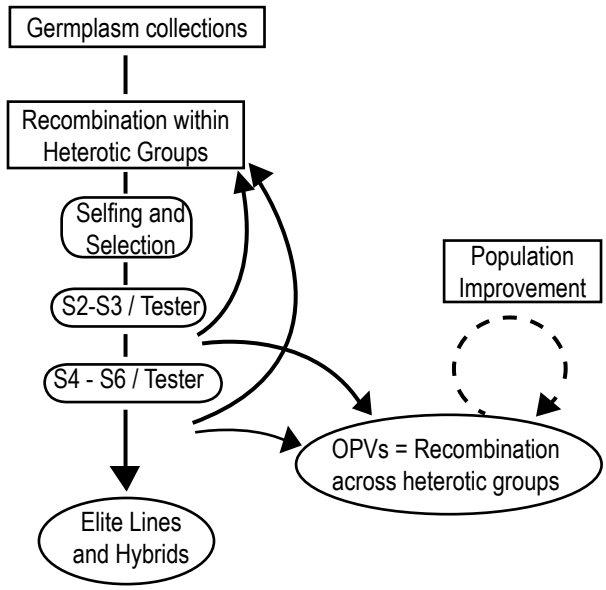


Figure 4.7 A generalized scheme of the pedigree breeding method used in maize.

The success of a breeding program, while largely dependent on the breeder's skill of observation and selection, and on the follow-through with seed production and marketing, is ultimately measured by the registration of new varieties and their uptake by farmers. However, at the breeding level, certain basic and essential components are required to increase the probability of identifying improved, adapted, and appropriate varieties. These include the following four factors:

> From a purely business-oriented perspective, the only real test of a breeder's success is grower adoption/ acceptance of a breeder's product.
> Aline O'Connor Funk, 2007.

1. Creating genetic variance. The greater the variation in the germplasm under investigation, the more likelihood there is of finding the desired genotypes. However, the germplasm must contain the characteristics (or genes) that one is interested in. Consequently, it is important to start breeding with the best sources of germplasm available.
2. Using heritability. This refers to the extent to which the genes of a plant are expressed in a discernable way. Traits or characteristics vary in their heritability and may be significantly affected by the environment in which the plant grows. For example, yellow grain is highly heritable and little affected by the environment, whereas drought tolerance has low heritability and is greatly affected by the amount of water available to the plant. Breeding progress is rapid with highly heritable and mono-genetically inherited traits such as maturity, grain color, grain texture, plant

height and resistance to some diseases, but slow with polygenic and low heritable traits such as yield, tolerance to abiotic stresses and ear diseases because they have low heritability and a high degree of environmental interaction. To improve the heritability of traits, good and uniform breeding nursery and trial management practices are required.

3. Selecting intensely. The greater the intensity of selection, the greater the breeding progress. However, in order to select intensely, there must be a large pool from which to select. This requires good observational and measurement capability, coupled with computer-aided statistical tools, to identify and retain desirable phenotypes. Breeding programs often battle with two problems—having enough resources to increase the variability of source germplasm, and not rigorously discarding undesirable phenotypes. Breeders need to be bold enough to throw out the rubbish and only select the best for advancement to subsequent stages of product development. Furthermore, greater progress is made by only pursuing a few breeding goals at once. The more traits that are selected for, the more difficult it is to make progress. Thus, breeding progress is often a step-wise selection process.
4. Relating breeding to the real target environment of customers. Crop breeding is typically carried out on research stations under ideal conditions. Although the stations may be located within the target market mega-environment, they are well-managed and not always typical of farmer fields. Consequently, breeders need to establish managed-stress environments that typify one or more of the most significant stresses that farmers face (see Box 4.1), and have a testing procedure that screens the products of research in those environments that exist in the target market.

Box 4.1 Common types of managed experiment environments for maize

- **Well fertilized/rainfed conditions:** Experiments are grown using optimal site-specific agronomic practices. In some instances irrigation may be applied to ensure that the trial does not undergo any water-deficit stress. Thus, these experiments generally express the environmental potential yield of the location.
- **Managed nitrogen stress:** Experiments are grown in fields that have been depleted of soil nitrogen by growing unfertilised, non-leguminous crops for several seasons and removing all the crop residues after each season. Yields from these locations are usually 20 to 30 % of those of well-fertilised maize crops at the same site. In these experiments it is usually necessary to remove border plants at either end of the rows, as these edge plants have the benefit of less plant-plant competition and more access to soil nutrients.
- **Managed drought stress:** Experiments are grown during the rain-free period, with irrigation applied at the beginning of the season to establish a good plant stand. Irrigation is applied on a schedule during the vegetative growth period and then withdrawn from about the 10 leaf stage onwards, so that the crop undergoes drought stress during flowering and grain-filling. Average yields are typically 1 to 3 t/ha. In these experiments, it is important to segregate varieties according to maturity. Furthermore, the uniformity of irrigation application is extremely important for success.
- **Managed low-pH and low-P stress:** Trials are grown in fields that have high aluminium saturation (desirably ~ 60 %) and/or low amounts of plant available soil phosphorous (~ 20 % of recommended levels). Average yields are about 50 % of optimal maize yields at the same site.
- **Artificial inoculation/infestation with biotic stress factors:** Experiments may be uniformly inoculated or infested with biotic stress factors, e.g., E. turcicum, leaf hoppers to introduce MSV, and stem borers. At the post harvest stage, grain or dry ears may be infested artificially or naturally with grain weevils.

Speeding up the breeding process

Since crop breeding is a slow and expensive process, it is sensible to develop methods and use tools that speed up the product pipeline (Box 4.2). A number of strategies are available to improve efficiency and reduce the time taken to market new varieties:

- Grow two (or more) crop cycles per year. This is possible if the main season crop matures within 170 days and a suitable off-season location is available that permits growth of the crop. Although the off-season crop cycle may not provide an ideal selection environment, it offers the opportunity of creating test crosses and advancing inbred line development.
- Begin testing at an earlier stage of breeding. The sooner improved genotypes are tested and selected, the less undesirable germplasm needs to be carried forward.
- Ensure fast turn-around of data—when two cycles of crop are grown each year, more efficient progress can be made if the off-season cycle is only planted with genotypes selected from the main season tests. However, since there is only a short time period between harvest of the summer crop and planting the off-season crop, this is not

always possible. In-field electronic capture of data and statistical software can overcome this problem.

Box 4.2 Tools necessary for an efficient breeding program

- Access to appropriate source germplasm
- Uniform fields clearly demarcated
- Supplementary irrigation facilities
- Tape measures
- Land preparation machinery
- Tools for planting, whether by hand or machine
- Herbicide and pesticide application equipment
- Seed preparation and processing shed
- Seed storage facility, such as a cold room
- Pollination bags, shoot-bags, staplers
- In-field grain sheller, electronic weigh-bin and moisture meter
- Computers, both hand-held for in-field data collection and desk-top for data management and analysis
- Breeding software, such as Fieldbook
- Data analysis capability and archival abilities

In recent years, attention has been applied to biotechnology as a means of improving breeding progress. Marker-assisted selection, which uses DNA-based screening techniques, has been increasingly used, particularly in developed countries. The current methodologies are expensive and not always transferable across genotypes, and although it has shown much promise and utility, it is yet to make a significant impact in African breeding programs.

Another promising technology is the double-haploid procedure. This enables the creation of homozygous inbred lines two generations after the initial cross, which under normal breeding techniques takes more than six generations. The technique uses a double-haploid inducer line to cross onto a breeding population from which the breeder wishes to extract lines. The resultant seeds display a phenotypic marker to aid identification of the haploid seeds, whose embryo only carries the genome of the female breeding population. These seeds are germinated and treated with a chromosome-doubling chemical (colchicine), grown out in a nursery and self-pollinated. The resultant seed is homozygous. The process requires good laboratory and nursery facilities, but is not technically difficult. The use of the double-haploid technique offers a good possibility for seed companies to increase the rate of germplasm development.

As much as breeding is about the germplasm, methods and environments used, real progress will ultimately depend on the staff employed to carry out the work and on the financial resources allocated to the task. A breeding team consists of breeders, technical field staff, field laborers, and administrative personnel. Characteristics of successful breeders include knowledge of the maize plant and customer requirements, excellent observational abilities, willingness to "walk the rows", team leadership skill and perseverance. For technical field staff, meticulous accuracy and precision are critical work attributes. This is because mistakes and variability in fields and notes disrupt and

distort results leading to poor selections. Team work within the breeding program is also essential, for not only are there a multitude of tasks to be carried out in each cycle of breeding and testing, but each of these tasks has consequential effects on subsequent operations and crop stages.

Variety testing identifies products for the market

In a product development strategy, the germplasm development stage is followed by testing of the developed materials for suitability, adaptability and appropriateness. The development of germplasm is usually done with specific objectives of incorporating desired plant characteristics (traits) such as yield, drought tolerance, disease tolerance, nutrient-use efficiency, etc., into germplasm to produce improved varieties. The effectiveness and suitability of these improvements must be evaluated in the field in a variety testing and verification programme. This involves various methods of variety evaluation trials and experiments.

The importance of managing trials to the highest standard cannot be understated. Hallauer and Miranda (1988) wrote, *"The skill of the breeder in selection and the **precision of testing** [are key] to the effectiveness of developing lines and hybrids"* (emphasis added). The elements of successful trial management include:

- Selecting the best type of experimental design to achieve the objectives of the work.
- Conducting the experiments in a planned, appropriately located and carefully executed manner.
- Taking care to collect the most relevant, accurate and precise information to best characterize the treatments.
- Using the best statistical techniques to enable the most rational choices between treatments.

A research worker may choose amongst many types of trials to evaluate technologies, viz., observations, experiments, on-farm trials and demonstrations. The choice will largely depend on the stage of development of the technology. New technologies are first evaluated under observation trials or statistical experiments, before they are tested in farmers' fields with on-farm trials and demonstrations (Figure 4.7). The main types of trials and their uses are as follows (Tattersfield, personal communication, 2004)

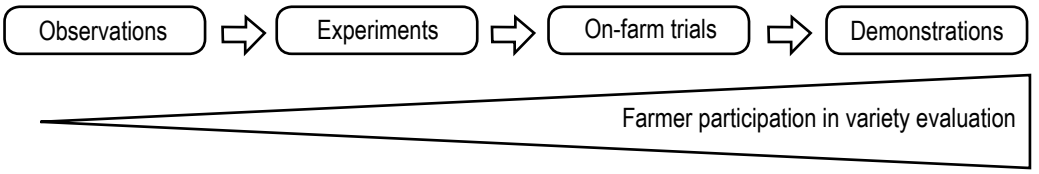


Figure 4.8 The usual sequence of experimental events used for introducing of new technologies to farmers.

Note: As the process moves from left to right, farmer involvement in variety evaluation and selection increases.

1. Observations. Observations are used to evaluate previously untested technologies in a simple comparative manner with existing technologies, usually on experimental stations under close supervision, in order to determine whether they have any merit at all. Observation trials may or may not be statistically designed, depending on the resources available. For example, if a new variety is created or introduced from another region, there may not be sufficient seed for widespread experimentation, but only enough to compare the new variety with existing varieties in small plots. If the new variety shows promise, it may be multiplied for further testing in other types of experiments and in more environments.

2. Experiments. An experiment is a method of statistically evaluating treatments in order to obtain a reasonable assurance of detecting meaningful differences (Steel and Torrie 1980). Experiments are designed to answer specific questions, and so they are established with some key necessities: treatments appear more than once in the experiment; experimental error is reduced by controlling the experimental conditions; records are taken that are relevant to the question(s) asked; and statistics are used to evaluate treatment effects and extent of experimental error. Agricultural experiments have traditionally been conducted on research stations, but in recent decades more and more experiments are conducted in farmers' fields or under conditions that represent farmers' fields. Experiments form the backbone of variety testing. Typically, an experiment will consist of 20 to 50 varieties evaluated against one or more check varieties. Such an experiment may be planted at a number of locations to sample various environments. Terminology related to experiments include:

Experimental unit or plot – The unit of material to which one application of a treatment is applied. Thus, in a maize variety trial, a plot will have particular variety assigned to it.

Treatment – The item of investigation, such as a variety or quantity of fertiliser, the effect of which is to be evaluated.

Replicate – A set of all the treatments. An experiment usually has two or more replicates. Each replicate is established and maintained in the most uniform conditions possible, but conditions of the replicates may differ from one another.

Randomisation – Within each replicate, treatments are randomised in a manner determined by the experimental design.

Experimental Design – The statistical arrangement of treatments in the experiment, determined by the objectives of the experiment, number and nature of treatments, and the conditions under which the experiment will be conducted.

Trial – A multi-location experiment.

Check – A treatment that is commonly known and used in crop production, against which the other treatments may be compared. Variety checks should be of similar type, maturity and vigor to the experimental varieties.

Variable (or Trait) – Factor under investigation, e.g., yield, time to flowering, etc.

Stage of testing – Preliminary, intermediate and advanced variety testing, related to the stage of inbred line development and test-cross evaluation.

3. On-farm trials. Experiments are suitable for establishing whether differences exist between treatments, but they may not always provide information on the adaptation of a variety in farmers' fields or the acceptability of treatments by farmers. Consequently, on-farm trials have been developed that enable farmers to participate in the evaluation of treatments and varieties. These types of experiments are conducted in situations very similar to those of the farmer, and often in the farmer's field. The main types of on-farm trials include strip trials and mother-baby trials. Strip trials evaluate three to eight varieties in un-replicated 6- to 8-row plots across a farmer's field. The mother-baby trial design consists of two types of experiments, viz., a researcher-managed 'mother trial' and farmer-managed 'baby trials'. The mother and baby trials are located on farmers' fields. The maize varieties are therefore evaluated under 'real' farmer conditions and they create opportunities for communication and interaction between all stakeholders, represented by the farmers, breeders, extension staff and seed companies.

4. Demonstrations. These are used to illustrate previously-tested and approved varieties or technologies to farmers. Usually, only a few varieties are demonstrated in comparison with known and commonly used check varieties on relatively large, unreplicated plots in farmers' fields. Demonstrations of the same set of technologies may be conducted at many locations. Farmers are invited to visit and evaluate the varieties, so that they may become familiar with them and be encouraged to adopt

appropriate options into their own farming practices. The treatment effects on crop growth are only evaluated subjectively. In some cases, however, records of yields and plant characteristics may be taken, but these are of little statistical or reporting value, unless the number of locations of a demonstration is 20 or more.

Seed production research ensures that new varieties are producible

The development of new varieties, particularly hybrids, should not ignore issues of seed producibility. As a new variety progresses towards the stage of variety registration, it should also be evaluated for seed production characteristics. The five key factors that determine the seed production potential of a hybrid are:

- Female seed yield. This is of primary concern as it has a significant impact on volumes produced and seed pricing. Hybrids with low-yielding females would need to have a higher price per ton of seed than high-yielding females to maintain good returns per unit area to farmers.
- Nicking, i.e., the relative flowering times of the male and female plants determine the required planting dates of male and female components. A perfect nick of male pollen shed and female silk emergence is most desirable, while a delayed male planting is preferable to a pre-planted male. Hybrids that require staggered male and female planting dates may only be satisfactorily produced with irrigation application at planting time.
- Female agronomic characteristics, such as tassel exertion and height, disease resistance, susceptibility to lodging and seed size. Female plants that are not too tall for detasseling, and which do not shed pollen while the tassel is still enfolded in the flag leaf, are desirable.
- Female seed characteristics, notably, ear rot resistance, ease of shelling, seed durability (i.e., resistance to seed cracking and damage during processing) and seed size (some seed markets prefer certain seed sizes).
- Male agronomic characteristics, especially pollen production potential and duration, maize streak virus resistance, and susceptibility to root lodging.

A seed production research program will therefore examine the male and female components of elite hybrids under a range of management practices, such as different planting dates, variable plant densities, herbicide application and fertilizer regimes. The results from these would contribute to the final decision of whether to advance a variety into the registration process and market release.

Registration of improved varieties enables seed production and marketing to begin

Following the development and testing of varieties, those that are identified as being improved and appropriate must be registered with National Seeds' Authorities in order for seed production and marketing to begin (Figure 4.8). In most African countries, the registration of varieties is based on "value for cultivation and use" (VCU) and the concept of "distinct, uniform and stable" (DUS), both of which are discussed below. However, the modalities of variety registration are not the same in all countries (Langyintuo et al. 2008). In the majority of cases, the time taken from the point of promoting a variety into the registration process to registration of the variety may take from one to seven years. Lengthy variety registration periods simply delay the access by farmers to improved varieties and thereby negatively impinge on national crop productivity in the long term (Figure 4.9). Furthermore, especially for new seed companies, the cost and time required for registration of varieties is a hindrance to entering the market. Thus, seed companies need to strategically manage the variety registration process, by ensuring good early testing of new varieties, promoting improved varieties into the registration process in a timely manner, and summarizing and presenting data to registration authorities in a clear and convincing manner.

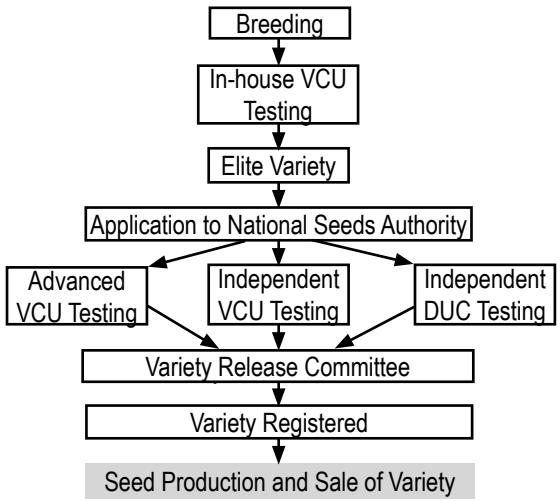


Figure 4.9 Schematic presentation of the variety registration process.
Note: The requirement for VCU and DUS tests, and the time taken for the process varies from country to country.

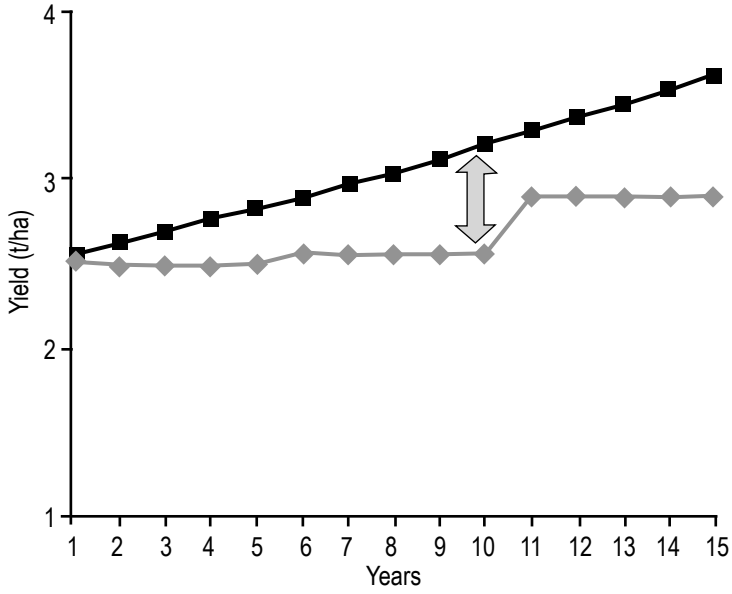


Figure 4.10 The theoretical effect of annual (squares) versus five-yearly (diamonds) release of new varieties, assuming a 2.5 % annual breeding yield gain.

Note: The double arrow indicates the cumulative yield gap that arises from delay in release of a new variety.

Value for Cultivation and Use

Value for cultivation and use (VCU) refers to two main aspects of variety performance (Tattersfield, personal communication, 2005):

1. Characteristics which relate to the suitability of a variety for cultivation under field conditions (C). These will vary depending on the crop species but the following are common to most crops:
   a. Yield – potential and stability, which in many cases is the most important character considered.
   b. Resistance to diseases, insect pests and nematodes.
   c. Good agronomic characteristics, e.g., resistance to lodging, suitable stature, rapid and even dry down, ease of harvesting, etc.
   d. Adaptability to the environment, e.g., time to maturity, resistance to drought, efficient use of nutrients, etc.
2. Characteristics which are associated with a variety's use (U). This is largely crop specific and varies widely with different crops, for example:
   a. With cotton, the lint quality.
   b. With wheat, the milling and baking quality.
   c. With potatoes, the shape and cooking quality of the tubers.
   d. With sunflowers and soyabeans, the oil content of the seed.
   e. With maize, the color, poundability and milling characteristics of the grain.

The main objective of plant breeding and the basis of using VCU as part of the variety registration procedure are to show a clear (statistically valid) improvement in one or more of the variety's characteristics over the varieties commonly grown. In order to demonstrate this, it is necessary to conduct variety trials and, in some cases, laboratory assessments, to objectively measure the characteristics of new candidate varieties against well known standard varieties (commonly called check varieties). The selection of the appropriate check variety is critical to this procedure. Essentially, the check variety must be of the same vigor (i.e., OPV or hybrid type), of similar maturity and used for the same purpose as the candidate variety, and be widely grown in the target market.

The methods of comparison of the candidate variety with the check variety may be many, but they must be based on an adequate data set from trials conducted within the target market. Since the performance of crop varieties usually exhibit a significant interaction with environments, the data set must include experiments across locations and seasons. Generally, it is unlikely that a candidate variety will be better than the check in every experiment. So, from experiments that are statistically significant, the performance of the candidate in relation to the check variety is examined on the basis of averages, ranks and frequencies, both in particular environments and across environments. Data may be presented in tabular and graphical ways to provide an objective means to satisfy decision-makers that the new product has an advantage over an existing check variety for the farmer and the end-user. Consequently, appropriately located experiments conducted using accurate and precise testing techniques, together with valid statistical methods, are required to enable meaningful comparisons to be made.

One of the main problems with using VCU for variety registration is that it is a subjective value judgment of a variety's usefulness for cultivation and use, albeit based on objective data. The question is, "Who is best qualified to make this value judgment—the seed company, the registration authority, the farmer or the end-user?" Assuming the variety testing procedures were adequately done, a seed company will only present a variety for registration if it is confident that the variety will be acceptable in the market. However, the ultimate decision of whether the variety may enter the market is commonly determined by a committee convened by the National Seeds' Authority, at which the developer or representative of the candidate variety acts solely as a promoter and defender of the value of the variety. Although this committee is usually a multi-stakeholder body, the members have little actual knowledge of the variety and can only make a judgment on the basis of the data presented. Accordingly, it is essential that seed companies prepare and present adequate and defendable data to such committees.

The definition of "distinct, uniform and stable"

In most cases where a country maintains a registry of varieties, each variety must be phenotypically distinguishable and designated with a unique name. The basis for defining varieties is usually in accordance with the UPOV Convention (International Union for the Protection of New Varieties of Plants, 2002). This system allows for the protection of a variety that is distinct (D) from any other variety whose existence is a matter of common knowledge at the time of registration, and that is sufficiently uniform (U) and stable (S). The evaluation of a variety for DUS is based on evaluation of the plants while growing under ideal conditions. The examination produces a variety description, using certain characteristics, such as plant height, plant architecture, flower color and maturity.

According to the UPOV Convention (International Union for the Protection of New Varieties of Plants, 2002), the definitions of distinct, uniform and stable are as follows:

- Distinct (D): a variety must be clearly distinguishable from any other variety whose existence is a matter of common knowledge. The distinction must be consistent and clear.
- Uniform (U): a variety is deemed uniform if it is "sufficiently homogeneous, having regard to the particular features of its sexual reproduction or vegetative propagation." The variation that a variety exhibits with respect to a characteristic must be consistent with the method of propagation of the variety. Thus, variation of a characteristic, such as plant height or silk color, is acceptable in an OPV but not in a single-cross hybrid.
- Stable (S): a variety "must be stable in its essential characteristics, that is to say, it must remain true to its description after repeated reproduction or propagation or, where the breeder has defined a particular cycle of reproduction or multiplication, at the end of each cycle." Similarly, Article 9 of the 1991 Act of the UPOV Convention requires that a variety "shall be deemed to be stable if its relevant characteristics remain unchanged after repeated propagation or, in the case of a particular cycle of propagation, at the end of each such cycle." (Note that this definition does not apply to yield, but only to certain defined phenotypic characteristics.)

The determination of DUS is usually carried out by the National Seeds' Authority under controlled and optimal conditions. Usually, for maize, particularly hybrid maize, or for self-pollinated (true-breeding) crops, a single growth cycle is sufficient for the DUS test. In some cases, two-seasons of testing may be required to evaluate stability (S). Apart from the time taken (and possibly also the cost, if there is a fee for this test), seed companies should not normally face problems with DUS testing. With

prior arrangement, inspections may be possible in the breeder's nurseries which is an important consideration when working with proprietary germplasm or where DUS of parental material may be required. However, in order for this process not to delay market access unduly, the product development strategy must take the DUS aspect of product registration into account in terms of time-lines and seed availability. The good thing about the DUS test is that apart from some subjectivity related to examination of plant characteristics, once a variety has been shown to be distinguishable from all other known varieties, there is no valid reason for disallowing its registration of the new variety.

Plant Breeders' Rights

Plant Breeders' Rights (PBR) and Plant Variety Protection (PVP) regulations are a collection of legal instruments that enable the recognition of the proprietary rights of a breeder or institution that developed a given variety. This protects the owner of a variety from un-informed use of the variety for seed production and in some cases, breeding. The owners of a variety may enter into royalty-bearing agreements with third-party users of a variety protected with plant breeders' rights. Thus, plant variety protection legislation provides a means to give returns to breeders for the investment made in variety development.

Plant variety protection is not the same as variety registration, although anyone who registers a variety becomes the de facto "owner" and maintainer of a variety, since no single variety may normally be registered by more than one person or institution. Variety registration is essentially an instrument related to seed certification procedures and is based on both VCU and DUS tests, whereas plant variety protection grants legal ownership of a variety to the developer of the variety and is only based on the DUS test. Not all countries of Africa have plant variety protection legislation, which may be perceived as a hindrance for seed companies to enter those markets. Where PVP or PBR legislation does exist in a country, it is necessary to make a specific application for such rights in addition to registering a variety for commercial release.

Allocation of financial resources to the product pipeline

The process of product development is a continuous chain of events from breeding to market launch. Since markets are frequently shifting due to changes in farmer preferences, consumer and industrial requirements, environmental impacts and activities of competitors, seed companies need to be agile and active in product provision. The problem that often faces managers is how to allocate resources to the product

development pipeline so as to optimize new product output. Resources available for research are usually limited because of the common and rightful emphasis on production and marketing. But, too often, research is considered a luxury rather than an investment, or as an overhead expense rather than a marketing cost.

When research is considered to be an integral part of the marketing strategy, then it will receive appropriate attention and resources. Nevertheless, there will always be competing demands for the limited financial resources of a company. In making decisions on how to allocate finite funds to research, two principles may serve as a guide:

Principle 1: Apply resources where they will be most efficiently used. In other words, invest where there will be the greatest return. At first impression, research may seem to give a low rate of return, but if one considers that it is only through product development and registration that a seed company will have products to market, it is obvious that investment in research can have high pay-offs.

The key is to invest in research in order to build the product portfolio of the company so as to give a competitive edge and enable market penetration and expansion. Whether or not a seed company needs a fully-fledged breeding and testing program has been discussed above, but it will be recalled that at the very minimum, a testing program will be needed to identify improved varieties, whatever their source. Consequently, money spent in research must be on clear product goals, taking into account the capacity of the company and sources of varieties, measuring the return according to variety performance and value addition. Furthermore, money spent in research must be efficiently used. Tight product development time-lines and milestones need to be defined, and key performance indicators indentified. Managers need to know how much it costs to develop a new variety and work at reducing this cost by improving efficiencies in research procedures and monitoring of expenses.

Principle 2: Apply resources to the most limiting process or component of the variety development pipeline. This may be assessed in a number of ways. First, examine the age-analysis, value contribution and market share of the current product portfolio, and evaluate the number and performance of new varieties in the various stages of product development (i.e., preliminary, intermediate and advanced testing) and in the variety registration stage. This may highlight particular gaps and deficiencies, and so indicate where resources need to be applied in order to optimize future variety availability. Second, examine the relative number of trial and breeding nursery rows, as this shows

the emphasis of breeders' activities. In general, the number of trial rows should be double the number of nursery rows because of the importance of testing in identifying superior products. Third, consider the quantities of pre-breeders and breeders seed, and experimental, pre-commercial and promotional seed production. Lack of such seed has often been the cause of failure of new varieties to impact the market. Finally, reflect on factors such as the competency and sufficiency of staff, the extent of new technology use, the number and location of testing environments, and other small factors that can make a big difference. An example of the latter limiting factor may be something as small as pollination bags—without these, maize breeding simply cannot proceed!

Key thoughts

1. To meet the dynamic market demands for improved, adapted and appropriate varieties, seed companies need to develop and implement a strategy to continually identify and register new products.
2. New varieties of maize and many other crops are available from public and private breeding programs. Consequently, at the very least, a seed company should maintain some kind of variety evaluation and registration procedure.
3. Where funds permit and market demands require, a proprietary breeding program may be needed to supplement other sources of germplasm. Plant breeding is a long-term and costly exercise. Therefore, breeders must have clear market-related product goals, use the best available breeding tools and methods, and have identifiable milestones to ensure market requirements for new varieties are met.
4. Breeding and variety evaluation ought always to involve the farmer, especially as new varieties approach the registration stage. Unless new varieties have been approved of by farmers, they are unlikely to make any impact in the market.
5. New varieties must not only be evaluated for farmer suitability and end-user utility, but also the producibility should be considered, as this may make a significant impact on profitability of the variety.
6. Registration of new varieties with National Seed Authorities requires that a candidate variety, through VCU tests, is shown to be better than an existing check variety in at least one significant trait. In addition, the candidate variety must be different from all other known varieties in at least one phenotypic character, as determined by the DUS test.
7. Knowledge of the magnitude of the components of the breeding and testing activity of the company will help managers to identify areas of weakness that need strengthening, and provide a means of projecting the outflow of new products.

5

Seed Production and Processing

The production component of a seed company generally comprises out-sourcing or contracting the actual production of seed with farmers, supervising this production to ensure certification standards are adhered to, and receiving the raw seed from the farmers for processing or conditioning into saleable product. The production strategy therefore plans the flow of this process to ensure that sufficient quantities of quality-assured seed are produced at each stage of the seed multiplication process, and that the certified seed is processed in time for the marketing strategy to be achieved. Thus, the production strategy is one major step in the process of ***HOW*** to achieve the objectives of the seed business.

Principal components of seed production management

The seed production process comprises a series of related and sequential components that begin with seed multiplication and lead to the warehousing of seed ready for sale (Figure 5.1). Since most crops take from three to six months from planting to harvesting, and a number of generations are usually required to achieve sufficient quantities of seed for retailing, the process is long and integrated, and careful planning of productions is required. Decisions that are made in one year affect the quantity of seed available for sale two- or three-years later. The production plan is therefore a long-term and integrated plan, and managers must take this long-term view into account in all production decisions.

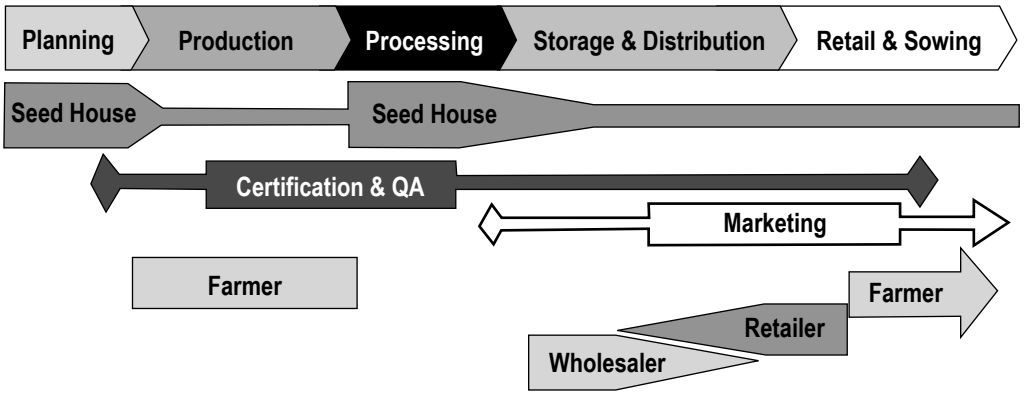


Figure 5.1 The components of the seed production process, which begins with planning and ends with seed being sold to farmers.

Note: Seed houses are usually directly involved with the planning and processing stages of seed production, but indirectly involved in field production and retailing of seed. During field production, the seed house oversees the certification procedures with farmers, implements Quality Assurance (QA) procedures, while the marketing activity involves distribution and sales of seed to farmers, usually through wholesalers and retailers.

Seed classes

The multiplication of seed from the initial small quantity that comes from the hands of the breeder through to the certified seed that is sold to farmers is a multi-season, multi-generational process, and in most seed regulations, these generations of seed are given specific seed class names (Table 5.1). Each generation from breeders' seed onwards will decline in genetic purity to some degree, but if strict production procedures are followed, this decline may be minimized. In the National Seed Regulations, the procedures for multiplying each seed class are defined, and will be discussed under certification procedures, below.

Table 5.1 The seed classes that normally apply to certified seed production in Africa, especially in those countries following the OECD certification standards.

Seed Class	Code	Produced from	Label Colors
Pre-basic Seed	A	Breeders' Seed	Violet band on white
Basic Seed (= Foundation Seed)	B	Pre-Basic or Breeder's Seed	White
Certified Seed (1st Generation)	C1	Basic or higher seed classes	Blue
Certified Seed (2nd Generation)	C2	C1 or higher classes of seed	Red
Quality Declared Seed	QDS	Complies with special requirements	Green

Note: In some countries, basic seed is termed "foundation seed." The quality declared seed class may not exist in some countries, while there might be an alternative, but similar, seed class called "standard seed." The label colors might differ from country to country (SADC Secretariat, 2008).

Planning seed production requirements

The seed production plan is closely tied to the marketing plan. Indeed, the marketing plan ought to determine the production plan and not *vice versa.* From the planned future sales, the current seed production plans are established based on the expected seed yields and seeding rates of the crops, varieties and parents to be produced, while also considering contingencies for production mishaps or increased sales' demand (Tables 5.2 and 5.3). It is usual for seed companies to plan to produce 25% to 30% more seed than the estimated sales requirements.

For open- and self-pollinated crops, the planning procedure is relatively straight forward, since scale-up production is a linear multiplication of one genotype. However, for hybrids, the parental components have to be taken into account, and this might take a few seasons before sufficient seed of the final hybrid is available for sale.

"Seedplan" – A spreadsheet program to assist in seed production planning

Seed production planning may prove to be a complex task if a number of hybrid varieties are produced with many different parents. For example, each three-way hybrid has three inbred line parents plus the single-cross female parent of the final hybrid. Thus, four isolation parent-seed productions are required before certified seed production is possible. Poorly made plans or mistakes in production can have deleterious consequences on future sales and hence profitability. In order to assist the planning of seed production, CIMMYT developed a spreadsheet program called "Seedplan". This program is a set of spreadsheets that enables a seed producer to plan the seed production chain from breeder's seed through basic seed to certified seed, based on future sales goals and assumptions on seeding rates and seed parent yields. Copies of the program may be obtained from CIMMYT (www.cimmyt.org).

Seed calculations

$$\text{Seed required (kg)} = \frac{\text{Area (ha)}}{\text{Seed rate (kg/ha)}}$$

$$\text{Area required (ha)} = \frac{\text{Seed production plan (t)}}{\text{Seed yield (t/ha)}}$$

Table 5.2 An example of a "Seedplan" seed scheme for the future production goals of an OPV, ZM521, based on a yield estimate of 3.5 t/ha and a seed rate of 25 kg/ha.

Class	Requirement	2009	2010	2011	2012	2013
Certified	Production	-	100 t	200 t	400 t	1,200 t
	Area required	-	29 ha	57 ha	114 ha	343 ha
Basic	Production	0.8 t	1.5 t	2.9 t	8.6 t	
	Area required	0.3 ha	0.5 ha	0.9 ha	2.5 ha	
Breeder's	Production	10 kg	20 kg	61 kg		
	Area required	29 m2	58 m2	175 m2		

Note: The areas and productions represent the minimums needed, and therefore a seed producer might consider greater production goals to cater for unexpected yield losses or higher sales of certified seed.

Table 5.3 An example of a "Seedplan" seed scheme for the future production goals of three-way hybrid CZH03030 (CML444/CML395//CML539).

Class	Component	Requirement	2009	2010	2011	2012	2013
Certified	CZH03030	Production	-	100 t	200 t	1 000 t	10 000 t
		Area required	-	22 ha	44 ha	222 ha	2 222 ha
Basic	CML444/CML395	Production	0.50 t	1.00 t	4.80 t	48.00 t	
	(Female)	Area required	0.4 ha	0.7 ha	3.2 ha	32.0 ha	
	CML539	Production	0.20 t	0.40 t	1.90 t	18.70 t	
	(Male)	Area required	0.2 ha	0.4 ha	1.9 ha	18.7 ha	
Pre-basic	CML444	Production	0.10 t	0.10 t	0.60 t		
	(Female - female)	Area required	0.1 ha	0.1 ha	0.3 ha		
	CML395	Production	0.10 t	0.10 t	0.30 t		
	(Female - male)	Area required	0.1 ha	0.1 ha	0.2 ha		
	CML539	Production	0.10 t	0.10 t	0.50 t		
	(Male)	Area required	0.1 ha	0.1 ha	0.5 ha		
Breeder's	CML444	Production	1 kg	6 kg			
	(Female - female)	Area required	4 m2	24 m2			
	CML395	Production	1 kg	4 kg			
	(Female - male)	Area required	7 m2	27 m2			
	CML539	Production	2 kg	12 kg			
	(Male)	Area required	20 m2	120 m2			

Note: This scheme is based on a yield estimate of 4.5 t/ha for the three-way hybrid production, 1.5 t/ha for single-cross female production, 2.0 t/ha for CML444 and CML395 and 1.0 t/ha for CZL03014, and a seed rate of 17 kg/ha for the female, 8 kg/ha for the male and 25 kg/ha for the pure crop. The areas and productions represent the minimums needed, and therefore a seed producer might consider greater production goals to cater for unexpected yield losses or higher sales of certified seed. Similar schemes may be generated for single-cross or double-cross hybrids.

Variety maintenance and breeders' seed production

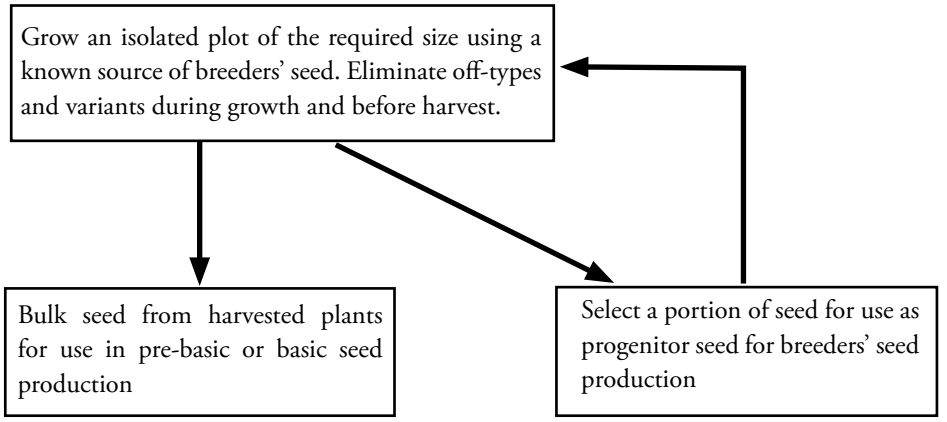
The maintenance of the genetic purity and uniformity of a variety is normally the responsibility of the organization that registers the variety in a particular country, and this task is usually assigned to the Breeder in the Research Department of the organization. The method of parent seed maintenance depends on the type of pollination that occurs in the crop species. Crops may be self-pollinated (such as groundnuts and soyabeans) or cross-pollinated (such as maize and sunflowers). For cross-pollinated crops, varieties may be either open-pollinated or hybrids, and in each case, different procedures are followed for the maintenance of varietal purity.

Maintenance and breeder's seed production of self-pollinated crops

Self-pollinated crops are relatively easy to maintain and produce Breeder's Seed. The procedure principally involves the growing of the crop variety in an isolated and identified plot using a known source of Breeder's Seed and eliminating any off-types and variants from the growing crop under supervision of the breeder (Box 5.1). The plot should not be planted in a field which had the same crop in the previous season, and good management should be applied to achieve optimum growth. The distance isolation requirement for self-pollinated crops is usually small, depending on the normal extent of out-crossing. The isolation distance recommended for Basic Seed is usually appropriate (Table 5.4), which for soyabeans, groundnuts, beans, cowpeas and wheat, is a distance of 10 m from a contaminant crop.

During growth of the crop, the breeder should inspect the crop regularly, particularly in the vegetative stage, at flowering and prior to harvest, to ensure that the plants conform to the characteristics of the variety, and that there are no off-type or variant plants. After harvest and threshing, the seed should be inspected to ensure that the seeds are of uniform and acceptable quality, and typical of the variety. A portion of the seed is kept by the breeder for future multiplication of breeders' seed, while that required for pre-basic or basic seed production is passed on to the production department. The size of plot required for breeders' seed production will depend on the multiplication factor of the crop and variety and the future requirements for pre-basic or basic seed production.

Box 5.1 Maintaining and producing breeders' seed of self-pollinated crops



Maintenance and production of breeders' seed of cross-pollinated crops

The maintenance of varietal purity of cross-pollinated crops, such as open-pollinated varieties of maize and sorghum, may be done either in isolated fields or under controlled pollinations. In either case, the plot used for breeders' seed should not be in a field that had the same crop in the previous season. A high standard of management is also required to ensure that the crop is grown under optimum conditions. During vegetative growth, off-type and variant plants should be removed, so that, at flowering, they do not contaminate the true variety. The maintenance and production of breeders' seed of a cross-pollinated crop variety depends on whether the variety is an open-pollinated or hybrid variety.

Production of breeders' seed of open-pollinated maize varieties in open-pollinated fields. Where the breeders' seed is produced in open-pollinated fields, it is essential that the crop is sufficiently isolated from potential contaminant crops to ensure that the breeders' seed is pure. Two methods of isolation may be employed. The first is to isolate by distance from a contaminant crop. In this case the distance between the breeders' seed plot and other maize should be at least equal to the requirements for basic seed Production (Table 5.4). The second method is to isolate by time, in which case the breeders' seed plot is planted in close proximity to, but either earlier or later than the contaminant crop by a time gap sufficient to avoid overlap of the flowering periods of the two crops. For maize, a time gap between plantings of the seed plot and the contaminant crop must be more than 28 days.

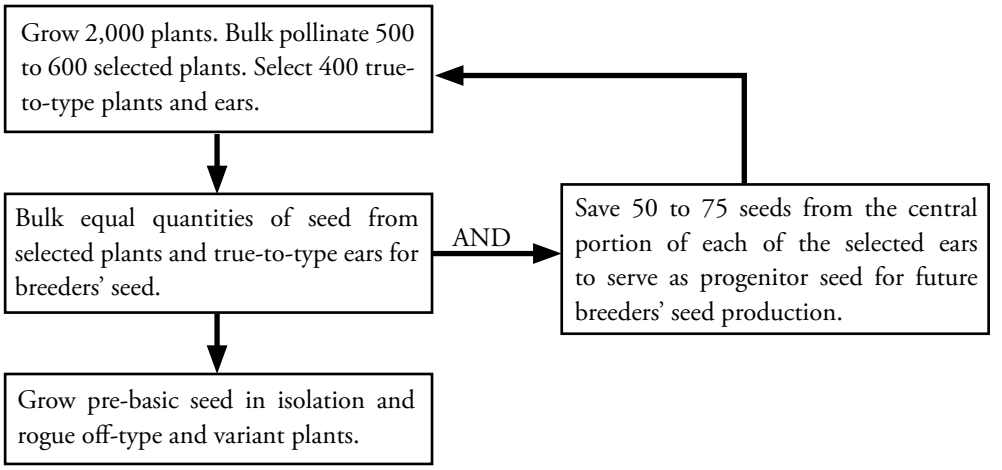
In the isolated field, the variety is grown from a known source of breeders' seed to achieve at least 2,000 plants. The size of the plot will depend on the demand for breeders' seed for basic seed production, but it is unwise to grow less than 2,000 plants. Off-type, variant and diseased plants are removed under supervision of the breeder prior to the flowering of the crop. The plot may be laid out in two ways:

a. Male and female rows may be identified, with the female plants de-tasseled prior to flowering to ensure cross-pollination from the male rows. The seed from the female rows is carefully selected from typical plants and desirable ears, with seed from at least 400 plants bulked for breeders' seed. The seed from the male rows may be discarded or used as basic seed.
b. The plot is grown as an open-pollinated field, with no separation into male and female rows. At least 600 plants that are typical of the variety are selected from within the field, and the seed from the central portion of the cobs is bulked for breeders' seed.

After shelling, a portion of the seed is kept for future breeders' seed production, while the remainder is passed onto the Production Department for Pre-Basic or Basic Seed production.

Production of breeders' seed of open-pollinated maize varieties under controlled hand-pollination. An alternative method of breeders' seed production in open-pollinated maize varieties may be with the use of full- or half-sib mating with hand-pollination. Seed of the variety is sown from a known source of breeders' seed to achieve at least 2,000 plants (Box 5.2). Off-type, variant and diseased plants are removed under supervision of the Breeder. Controlled hand-pollinations are made either by bulking pollen from identified male plants or from all typical plants and applying this to the female flowers of selected typical plants, or by pollinating female plants from individual male plants. Usually, at least 600 plants should be pollinated. The seed from at least 400 purposefully selected typical, disease-free plants with desirable cobs is bulked. It is advisable to discard the seed from the butts and tips of cobs and only keep the seed from the central portion of the cob. A portion of this is retained for future breeders' seed production, while the remainder is passed onto the production department for pre-basic or basic seed production.

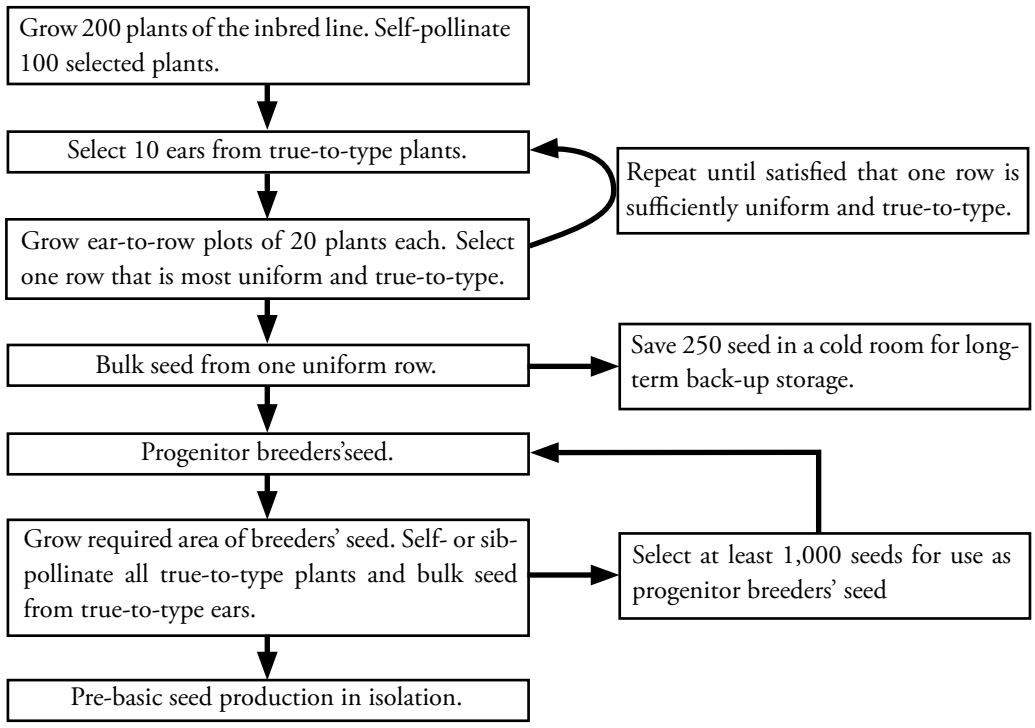
Box 5.2 Maintenance and production of breeders' seed of open-pollinated maize varieties



Maintenance and production of breeders' seed of inbred lines of hybrid maize varieties

With hybrid varieties the maintenance of varietal purity is vested in the maintenance of the parents, which in the case of maize are the component inbred lines (Box 5.3). The first step in maintaining inbred parents is to ensure that they are sufficiently pure and uniform. The second step is to multiply required quantities of breeders' seed for use in pre-basic and/or basic seed production.

Box 5.3 Maize inbred line maintenance and breeders' seed production



Inbred line purification is a process of ear-to-row selections until there is sufficient uniformity and purity for the purposes for which the hybrid is to be used. This may take two or three generations in cases where the source seed is from an S4 or S5 inbred population. In this case, ten or more rows of the inbred-line are grown, from which five to ten ears are selected from plants that best represent the line and which are agronomically superior (i.e., exhibiting best *per se* performance in terms of desired characteristics). These ears are grown ear-to-row, and through the growing season, one row is selected that is the most typical of the line and has the best *per se* performance. From this row, five to ten ears are selected and either bulked, if the row is sufficiently uniform, or grown as ear-to-row plots, if there remains some notable segregation in the row (e.g., with phenological characteristics, such as glume color, tassel shape, etc.). Once again, if the inbred line is grown ear-to-row, a single row is selected from the group, and the ears bulked, if the row is sufficiently uniform, or five to ten ears are selected for another generation of ear-to-row selection. Once the ears are bulked from a uniform row, the seed becomes the source of breeders' seed production.

For breeders' seed production of an inbred line, the required area is sown in a field that did not have the same crop in the previous season. Any off-type plants are removed

under the supervision of the Breeder, and typical, disease-free plants are self-pollinated or sib-mated using hand-pollination. At harvest, only ears that are typical of the line are selected. From these, a portion of seed is retained as a source for further breeders' seed production, while the remainder is passed on to the production department for pre-basic and basic seed production.

Certified seed production

Certified seed is seed of a consistently high and known quality (genetic and physical quality) that has been produced according to the rules and regulations of an official seed certification scheme and for which proof of certification is available. The rules and procedures for certified seed production are laid down in the seed regulations of the country in which the seed is to be produced. The aim of certification is to produce seed with a minimum acceptable genetic purity and specified physical quality in terms of germination percentage, seed moisture and seed physical purity. The certification procedures are based on standards for growing conditions, field isolation, crop inspections, prevalence of weed seeds, proportion of defect seeds, germination percentage and seed moisture content. If a seed field or seed lot does not meet the prescribed standards for the intended seed class, it will be rejected for certification.

The standards for pre-basic and basic seed production are higher than those for certified seed production (Table 5.4), particularly as regards isolation requirements and the maximum percentage of off-types. The standards are evaluated in every seed field by means of field inspections and laboratory tests. The field inspections are required to verify the origin of source seed and identification of the variety, determination of the cropping history, adequacy of isolation distance (or time), production practices, and to ensure that all certification procedures are adhered to. Usually, three to ten field inspections are required during the season, depending on the type of crop and variety. Hybrid maize seed production requires the most number of inspections, especially during flowering, to ensure the crop meets the certification standards. Following shelling or threshing, samples of seed are taken for laboratory tests to evaluate the purity of the seed, the germination percentage and the moisture content. This is the final stage in the certification process, and if the seed lot passes all the standards, it is granted certified status.

The inspections of seed crops for certification are carried out by "Inspectors" or officers from the National Seeds Authority or with accredited inspectors employed by the

seed company. Where inspectors from the National Seeds Authority are used, forward planning of appointments is necessary to ensure that inspections are timeously carried out. Many a seed crop has failed certification simply because inspections were conducted at the right time. Accredited company inspectors must have the necessary equipment and mobility to visit seed fields as required. Inspectors may be assigned to a manageable number of seed producers for a season or two, but it is wise to rotate inspectors amongst farmers over time to avoid familiarity and decline in standards. The number of fields that an inspector can manage is a function of the seed field sizes, distance between fields and range of planting dates.

Table 5.4 The minimum SADC seed certification standards.

CROP		FIELD STANDARDS						LABORATORY STANDARDS				
Botanical Name	Common Name	Minimum isolation distance (m)		Maximum % of off-types (based on 1000 plants)		Minimum number of inspections		Minimum germination (%)		Minimum % pure seed (by weight)		Max. Moisture (%)
		BS (B)	CS (C)	BS (B)	CS (C)	BS (B)	CS (C)	BS (B)	CS (C)	BS (B)	CS (C)	(All Classes)
Arachis hypgoaea L.	Groundnut	10	5	0.2	0.2	3	3	75	75	98.0	98.0	9.0
Cajanus cajan L.	Pigeon Pea	400	200	0.1	0.3	3	3	75	80	99.0	98.0	13.0
Glycine max L. Merrill	Soybean	10	5	0.2	0.5	3	3	70	70	99.0	99.0	12.0
Gossypium hirsutum L.	Cotton (H)	500	400	0.2	0.3	3	3	70	75	99.0	98.0	10.0
Gossypium hirsutum L.	Cotton (OP)	100	100	0.2	0.3	3	3	70	75	99.0	98.0	10.0
Helianthus annuus L.	Sunflower (OP)	1000	800	0.2	0.5	3	3	75	85	98.0	98.0	10.0
Helianthus annuus L.	Sunflower (H)	3000	1500	0.2	0.5	5	5	80	80	98.0	98.0	10.0
Nicotiana tabacum L.	Tobacco	800	400	0.2	0.5	3	3	85	85	99.0	99.0	8.0
Oryza sativa L.	Rice	5	5	0.2	0.3	3	3	80	80	98.0	98.0	12.5
Pennisetum glaucum L.	Pearl millet	400	200	0.5	0.5	3	3	75	80	98.0	98.0	11.0
Phaseolus vulgaris L.	Beans	10	5	0.1	0.2	3	3	70	75	99.0	99.0	13.0
Sorghum bicolor L. Moench	Sorghum (OP)	400	350	0.2	0.5	4	3	80	80	99.0	98.0	12.0
Sorghum bicolor L. Moench	Sorghum (H)	750	500	0.2	0.5	5	5	80	80	99.0	98.0	12.0
Triticum aestivum L. emend. Fiori *et* Paol.	Wheat	10	5	0.1	0.3	3	3	85	85	99.0	99.0	13.0
Vigna unguiculata L. Walpers	Cowpea	10	5	0.2	0.5	3	3	75	75	99.0	98.0	13.0
Zea mays L.	Maize (OP)	400	200	0.5	1.0	4	3	90	90	99.0	99.0	13.0
Zea mays L.	Maize (H)	400	350	0.1	0.3	5	5	70	90	99.0	99.0	13.0

Note: BS = Basic Seed; CS = Certified Seed. Standards may be different in individual countries in SADC and elsewhere.

Source: SADC Secretariat, 2008.

Field management of seed production, with particular reference to maize

Since seed production is a higher value crop than grain, the standard of management to be applied ought to be higher. However, in principle, the agronomic practices applied to seed crops are not dissimilar to normal crops, particularly if self- or open-pollinated crop seed is grown. With hybrid seed production, where one or both parents are inbred lines, extra care and attention might be necessarily applied to the inbred components, since they tend to be weaker and more susceptible to environmental stresses (e.g., disease, herbicide and nutrient stress) than hybrids.

Keys to good crop management

Crop management may be distilled down to three cardinal points, viz, timeliness, adherence to high standards and minimization of wastage of inputs (Brian Oldrieve, personal communication, 2005).

Timeliness. Timeliness is of utmost importance in seed production. All seed crops develop in a certain sequence from sowing through to maturity, and management of the crop is determined by this growth pattern. Every management decision must be taken and every input applied at the most appropriate time for the crop (Figure 5.2).

The establishment of a crop is generally the most important stage in the whole cycle, since decisions taken at sowing impact on the whole of the life cycle of the crop. Most summer field crops, like maize, cotton and soyabeans, yield more when planted early than late. In some hybrid seed crops, the time of male and female planting needs to be staggered to ensure synchronization of the male and female flowers. In some cases of seed production, the required isolation of the crop is achieved by planting the crop at a time that is sufficiently different from a contaminant crop to ensure that no foreign pollen contaminates the seed crop. Thus, in order to plant at the best and correct time, good plans need to be made. This involves setting deadlines for various operations, like land preparation, purchase of inputs, application of fertilizer, planting date and so on. This is best done on a calendar well ahead of the deadlines and the work scheduled to meet the deadlines, making sure everything needed is in place for the optimum planting date.

However, the importance of timeliness extends beyond planting to all aspects of seed production. Operations such as weeding, top dressing, pesticide applications, de-tasseling of females, male removal in hybrid seed and harvesting all have to be done at the right time where the work will bring forth the best results. It is an established

fact that weed competition during the first four to six weeks of a crop's life is most detrimental to yield. Also, small weeds are much easier to control than large weeds. Thus, timely weeding, when the crop and weeds are small will be most effective and beneficial to good seed production.

Removal of the male plants in hybrid seed production as soon after pollination as possible reduces competition with the female plants and improves the yield of the adjacent female rows. The male plants may be destroyed or removed from the field and used for stock feed. Ensuring the thorough removal of male plants avoids the possibility of mixing male and female seed at harvest.

The timing of fertilizer applications plays a crucial role in productivity. The application of nutrients to the crop ought to coincide with the requirements of the crop. The first consideration is the soil acidity, as this must be ameliorated prior to crop establishment. The basal fertilizer, usually comprised of compound mixture of nitrogen, phosphorus, potassium and sulfur, must be applied before or at sowing so that the germinating plants obtain required early nutrition for rapid growth. Likewise, the application of nitrogen top dressings must be according to the plant's vegetative growth requirements and the environmental conditions. Late top dressing after peak vegetative growth will do little to enhance yield. Micro-nutrients to supply particular deficiencies in the soil or plant may also be required. In some situations, particularly where maize is grown on acid soils, hybrid seed maize crops may require sodium molybdate application, either as a foliar application soon after pollination or as a seed dressing after harvest.

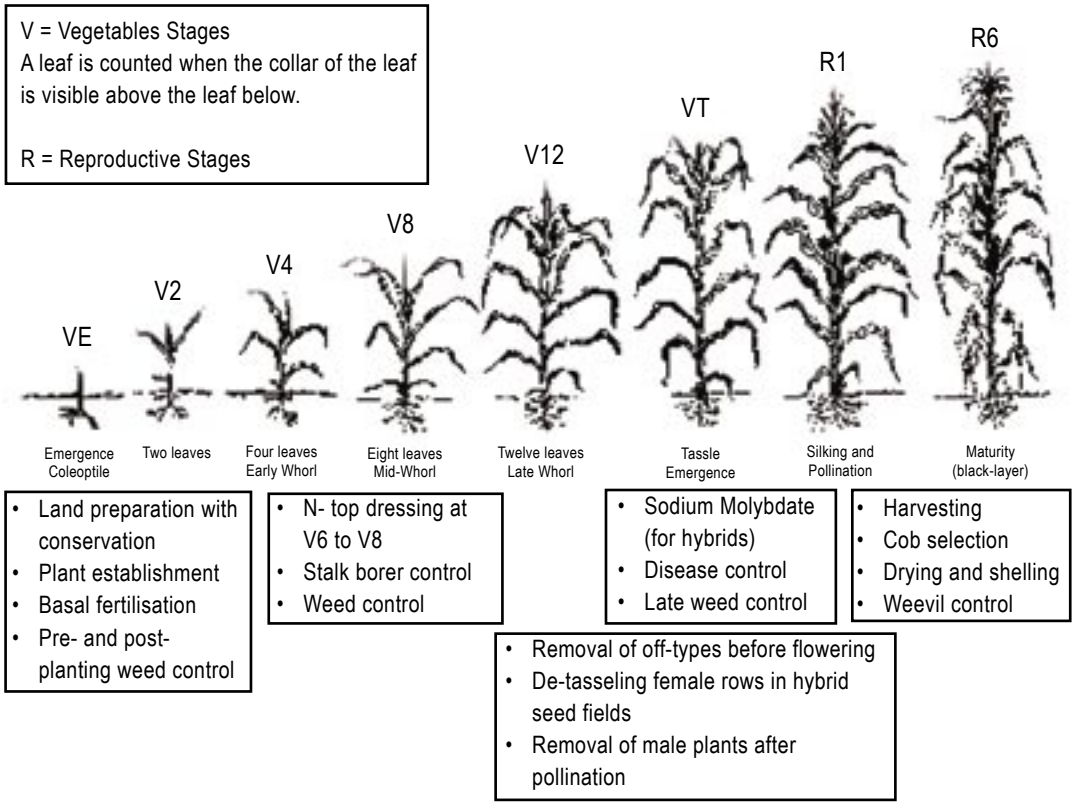


Figure 5.2 Schematic representation of the growth and development of maize, with basic management practices required at various stages of hybrid seed production.

Source: Anon., 2000. *Corn and Soybean Field Guide*. 2000 Edition. Purdue Crop Diagnostic Training and Research Center. Purdue University Cooperative Extension Service, Lafayette, IA.

Pesticide applications must also be timed to give the best control of weeds, pests or diseases. This can only be achieved if a regular and thorough scouting program is followed. When pests and diseases reach economic threshold levels, pesticides must be applied without delay, and in a manner that ensures the correct pesticide rate, application volume, spray method and safety measures are achieved.

With seed crops, time of harvest is crucial to ensure good seed quality. If the seed is harvested too early and drying and storage conditions are not ideal, the seed will rapidly lose germination capacity. If seed is left in the field for a long time before harvesting, it is exposed to deterioration, pest (disease, insect, bird and rodent) attack and is vulnerable to theft.

Standard of management. Managing to a high standard will increase the potential of any crop. This basically implies precision and accuracy of treatments to the crop.

Precision means a high degree of exactness, or simply doing things correctly. Accuracy implies minimal deviation from the standard, or simply doing things without error. The two go together. Things may be done with great precision, but they might be completely wrong or inappropriate. For example, a crop may be planted at a perfect spacing, but the spacing may be too close or too wide. Thus, good crop production depends on working precisely and accurately to a particular standard.

At the start of the season, the key issues are fertilization and sowing. Both these operations have a great influence on the potential of a crop. The quantity of fertilizer applied must be tailored to the yield target of the crop and the nutrient supplying capacity of the soil. The fertilizer must be applied in such a way as to give maximum crop response. Band application alongside and below the planting row or spot placement in the planting hole near the seed are the best methods, whereas broadcast applications of fertilizer are usually inefficient.

The spacing of plants in the field has a large effect on yield. For each crop (and variety) in a given environment there is an optimum plant population. The average response of maize to plant population indicates that the optimum range is between 36,000 and 60,000 plants per hectare (Figure 5.3). Higher populations may be used in high potential environments or with short-statured lodging-resistant varieties. The lower populations are suited to dryland crops and varieties that may be susceptible to lodging. Inbred lines are often sown at a higher density than hybrids because they are small-statured. The aim in plant establishment is to achieve the precise optimum population in an accurate manner. Gaps and uneven stands will reduce yield potential, whereas an even stand of equally spaced plants is ideal.

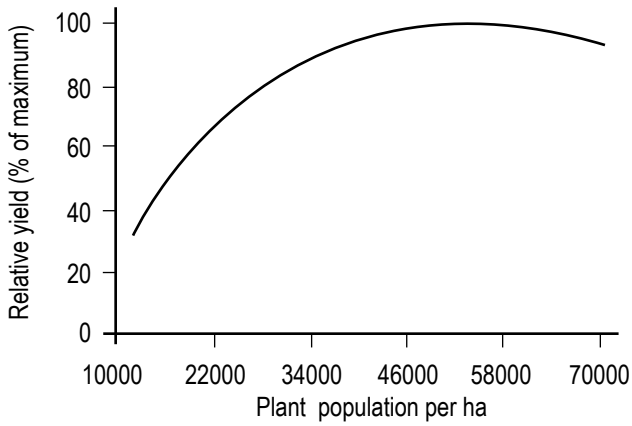


Figure 5.3 The typical response of maize to plant population under optimal conditions in mid-altitude moist environments of Africa.

Note: The shape of the curve and optimum density may vary depending on variety and environment.

Precision and accuracy also applies to other aspects of production, such as weed control, pesticide application and harvesting. This is particularly true for chemical spray applications. A renowned agronomist, Stan Sheppard, once said that pesticide spraying is one of the most inefficient and inaccurate agricultural practices. The chemical pesticides available today have particular rates, timings and techniques of application, which farmers must be familiar with and adhere to if they are to expect good results from their use. This information is given on pesticide labels, and of course, in all cases, safety procedures must be observed.

In hybrid seed maize production, de-tasseling of the female plants must be up to standard and conducted in a timely fashion. Any delays in de-tasseling, or poor de-tasseling techniques that result in tassel-stubs or missed plants will seriously impact on genetic purity and might result in rejection for certification.

Minimal wastage of inputs. The third point in productivity is efficiency of use of inputs. Although this may not always directly affect the yield of a crop, wastage reduces productivity and efficiency. All inputs are expensive, and therefore a farmer can simply not afford to waste anything.

Again, this principle applies to most aspects of production. Fertilizer must be applied without wastage. Crop chemicals should not be over-applied. Hand weeding should be done when weeds are small so that energy is not wasted. Only that amount of seed required to achieve the desired plant population should be used. A good example of how seed may be wasted is shown in Figure 5.4. Sorghum yields increased as the plant population increased to about 15 plants per m2, but thereafter, with higher seeding rates, there was little change in yield. In fact, with many crops, if excess seed is planted and high plant populations are achieved, yields may be decreased and lodging may be a serious problem. Thus, a farmer need only sow sufficient seed to achieve the optimum plant population, and no more.

The three keys to productivity, namely, appropriate timeliness, excellent standards and efficient use of inputs, apply to all aspects of seed production. The application of these principles is a matter of planning and determined implementation.

Synchronization of male and female flowering in hybrid maize seed production
Ideally in hybrid seed maize, the male plants should begin shedding pollen when the first female silks begin appearing. However, male and female plants might not always take the same time to reach the flowering stage. Furthermore, the duration of pollen

shedding should equal the duration of emergence and viability of female silks. Any mistiming of the male and female flowering may lead to reduced yields and expose the female seed parent to contamination from foreign pollen (Box 5.4).

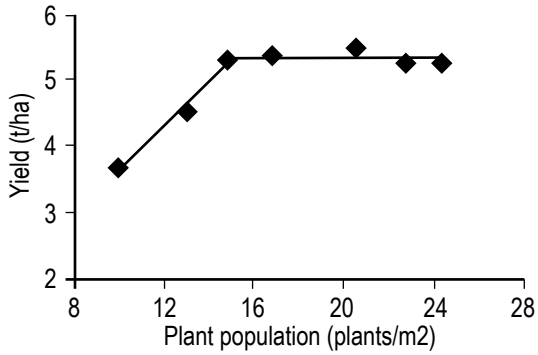


Figure 5.4 The effect of plant population on yield of sorghum in Zimbabwe in 1993/94.

Source: Agricultural Research Trust, Harare, Zimbabwe.

Pollen shedding and silk emergence may take place over seven to 14 days and may not coincide even if the male and female parents are planted on the same day. For example, the silks on the female may begin to emerge before the males begin to shed pollen (Figure 5.5). Indeed, the silks in the example were showing for some four days before significant pollen shedding occurred, thereby exposing the crop to possible contamination from foreign pollen. The time to 50% silking of the female occurred 64 days after planting, and the time to 50% pollen shedding occurred 67 days after planting of the male. To achieve a perfect nick in this hybrid production, the male would need to be planted three to five days earlier than the female.

In order to accommodate these differences in male and female flowering, seed producers need to have good information about the time taken from sowing to flowering, the duration of flowering and the pollen production of the male parent. If there is more than a two-day difference in the average time taken from sowing to mid-flowering of the male and female parents, it is advisable to adjust the sowing date of the male so as to ensure good synchronization. A male parent that sheds pollen earlier than the silk emergence of the female parent must be planted later than the female. Conversely, a male parent that sheds pollen later than the silk emergence of the female must be planted earlier than the female.

If a male parent has a weak growth habit, or it has a short pollen shedding period, or it does not produce a profuse amount of pollen, it is advisable to plant the male on two

(or even three) consecutive dates, a few days apart, so that the pollen shed period covers the whole period of silk emergence. The split-planting of the male is usually done in two adjacent rows in a 6:2 female: male row ratio. To reduce the proportion of land taken up by male rows, the two split-planted male rows may be planted relatively close, compared to the female rows. For example, if the normal row spacing is 90 cm, the two split male rows could be 45 or 60 cm apart, but 90 cm away from the adjacent female rows. In the case where the male does not produce an abundance of pollen, the ratio of females to male should not be more than 3:1, whereas if the male is a profuse pollen producer (like a hybrid or OPV in the case of a double-cross hybrid or top-cross hybrid), the ratio of females to male may be increased to 4:1 or even 6:1. In some cases, a ratio of 6:2 may be planted, but the male must be a prolific pollen producer.

Box 5.4 Reasons for seed crop genetic contamination

The main sources of genetic contamination of a seed crop are from:

- Seed admixture prior to sowing.
- Impure seed sources.
- Re-growth plants from the same crop grown in the field in the previous seasons.
- In maize hybrid production, incomplete de-tasseling of the female resulting in female selfing.
- Foreign pollen contamination due to inadequate isolation.
- Poor synchronisation of male and female plants in hybrid production exposes the female plants to a greater risk of contamination from foreign pollen.

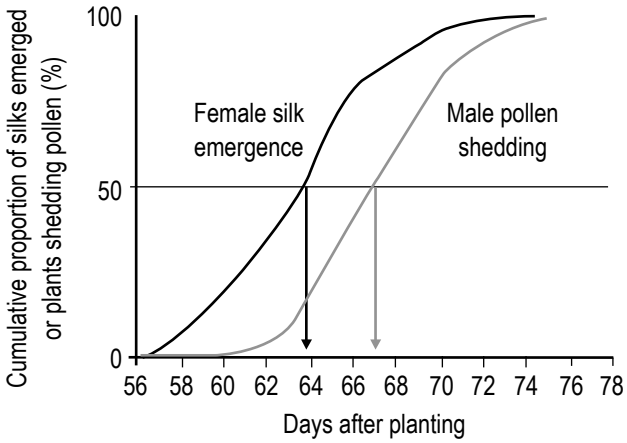


Figure 5.5 An example of the progress of silk emergence of the single-cross female and the pollen shedding of the inbred male in a three-way hybrid maize seed field.

With single-cross hybrid seed production, where the male and females are of similar vigor and stature, a "squeeze-row" configuration may be feasible. In this instance, the male is planted at half the normal row spacing between alternate rows of females. In other words, the females are planted in their normal row spacing, say 90 cm, and in every second inter-row-space the male is planted at 45 cm from the two female rows.

Thus, the effective female:male ratio is 2:1 but no extra land is used for the males, so the land area is optimally used. However, it is important in this system to remove the male immediately after pollination is complete so as to reduce competition with the female.

Other methods of improving synchronization that have been attempted, especially where there is a small time difference between the time of flowering of males and females, include the following:

- Water soaking seed for 12 to 24 hours prior to sowing may advance flowering by one to two days. Soaked seed absorbs water and begins to germinate, and is therefore vulnerable to damage if mishandled. Water soaking of seed is only feasible with hand sowing.
- Clipping the whorl-leaves of the male plants at growth stage V4 to V6 to delay tasseling and pollen shed. This is effective in delaying pollen shed by two to three days. However, if the plants are clipped too severely they might produce small tassels and less pollen than if not clipped. If clipped too late, there will be little effect on time of pollen shedding.
- Partially burning male plants with herbicides or flame at V3 to V5 to delay tasseling and pollen shed by two to three days. This has proven to be effective if the extent of burning is not excessive.
- Adding extra phosphate and nitrogen fertilizer in the planting furrow of the male or female to hasten plant growth. This may be effective in soils that are not very fertile, but the hastening of plant growth may only cause flowering to occur one to two days earlier than if no fertilizer is applied.
- Irrigation applied one to two weeks before flowering will ensure that the silks emerge at the expected time, especially if the weather is hot and dry at that time.
- In cases where male plants are insufficient due to germination failures, pollen may be collected from remaining plants, bulked into "pepper pots" and applied to the silks of female plants. This is tedious while the time between collection of pollen and application to silks must be less than two hours, otherwise pollen will lose viability.

Roguing

This is the systematic removal of undesirable seeds and plants from the seed field, with the goal of assuring that the seed crop meets the desired genetic purity standards. The process begins prior to planting, with selection of fields that are and will be free of volunteer plants, the use of genetically and physically pure source seed, and the maintenance of required isolations. Planting equipment should also be cleaned prior to sowing to remove foreign seeds. The vegetative phase of crop growth provides an ideal time to remove off-type plants from the field, particularly in the case of hybrid

and open-pollinated crops, where pollen contamination can be a major source of genetic impurity. With self-pollinated crops, roguing should preferably be complete by flowering, but may continue through to maturity. At harvesting, threshing and processing, clean equipment must be used, and undesirable seeds removed where possible. People involved in roguing off-type or variant plants must be well acquainted with the phenotypic characteristics of the variety. Rogued plants must be completely removed or destroyed to ensure no possibility of contamination.

Effects of poor synchronization on yield and grading of seed maize

Pollen too early relative to silks, or late silking relative to pollen shed

- The base of the cob will be pollinated, with the tips empty
- Yield loss will depend on the percent seed set, but kernels at the base of the cob are usually larger and compensate better than the normally smaller kernels at the tip.
- Expect a higher proportion of large round seed compared to other seed grades.

Silking too early relative to pollen shed, or late pollen shed

- The tips of cobs will be filled, with blind butts
- Yield loss usually high, since large butt kernels are missing, but small kernels on the tip are present
- The seed grades will be mostly small rounds and thicks, with a small proportion of the medium flat seed grade.

Seed maize harvesting and processing

The management of the growing seed crop plays an important role in the yield and genetic quality of the crop. If the crop has been managed appropriately from an agronomic perspective, and the weather conditions are favorable, the yields will be optimized. Likewise, if the field certification procedures have been followed correctly, the variety will be true-to-type, or genetically pure. However, from harvest onwards, the handling of the seed has a major influence on the physical and biological quality of the final product. Indeed, this is probably the most critical period in the seed business as it pertains to the seed quality. Thus, the seed business must pay particular attention to the harvesting and processing (including storage and transport) of the seed to be assured of quality seed.

Seed harvesting

The quality of seed, as measured in terms of germination percent and seed vigor (i.e., viability), improves from fertilization of the embryo through to physiological maturity, when it will reach a maximum (Figure 5.6). The absolute or maximum quality of the seed at physiological maturity will have been determined by the growing conditions during seed development, but whatever this quality is at physiological maturity, it will be the maximum that the seed can attain. From this point onwards, no improvement is possible in seed viability. All operations from harvesting onwards therefore have to be done in such a manner as to cause the least deterioration in seed viability, while ensuring that healthy seed is separated from inferior seed and impurities (extraneous matter and weed seeds) to achieve the specified standards for certified seed.

Box 5.5 De-tasseling maize – one of the most critical stages for ensuring genetic purity

- The tassels on the female plants in hybrid seed maize production must be removed before they begin to shed pollen.
- De-tasseling must commence when the top 3–4 cm of the tassel is visible above the whorl.
- De-tasseling must continue on a daily basis until complete, come rain or sunshine!
- The de-tasseling period may be two to three weeks, depending on the uniformity of the crop.
- Six people can normally de-tassel one hectare of seed females per day.
- Individual workers may be allocated specific sections of the field to de-tassel, so as to give responsibility and accountability.

At physiological maturity of the crop, the seed has a high moisture content (between 30 and 38 % in maize) and the crop will still have some vestiges of green in the stems and leaves. From physiological maturity onwards, the seed dries as the natural environment allows (Figure 5.7). The drier and warmer the environment and the greater the exposure of the seed to the air, the faster will be the decrease in seed moisture. The rate of field dry-down will also be increased in cases where the cobs have few husk leaves, the cobs are covered by loose husks, and where the diameter of cobs is small. Seed quality will remain relatively high, and only decrease slightly, if at all, as long as environmental conditions favor the maintenance of seed quality.

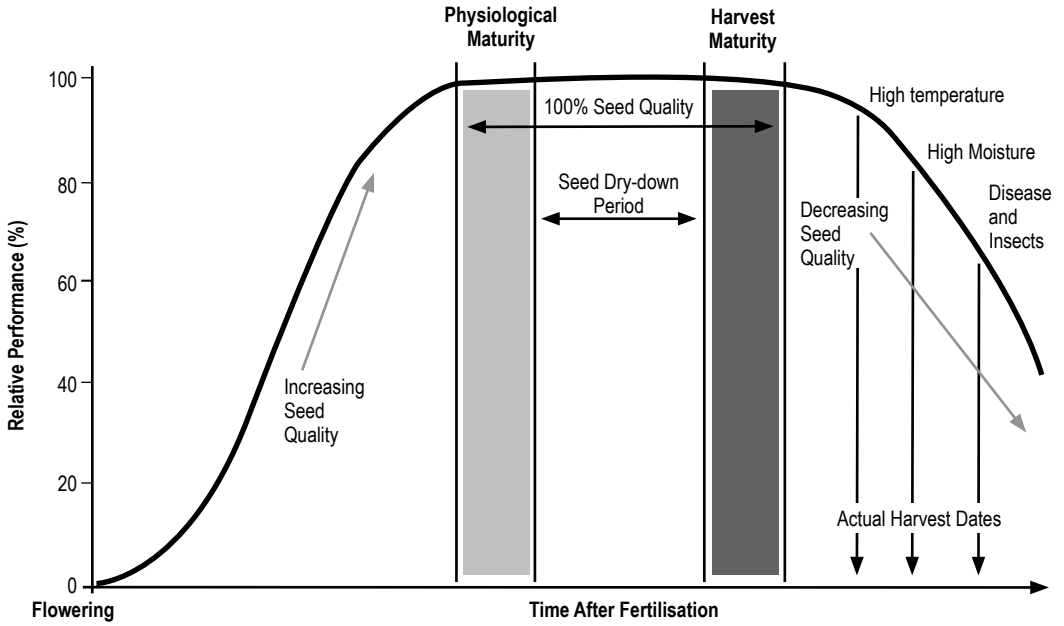


Figure 5.6 Schematic presentation of the change in seed viability (germination percent and vigor) with time after fertilisation of the embryo.

Source: Adapted from Andrews and Cabrera (1995).

The quality of the seed will decline if environmental conditions become adverse, with high air temperatures, high moisture (or high relative humidity), seed diseases and grain borers having the most negative impact on seed quality. Thus, harvesting of the crop must be timed to ensure that the seed has the highest possible quality, which basically means that the crop should be harvested as soon after physiological maturity as possible and feasible.

Early harvesting of seed crops is not always possible because of the nature of the seed. For example, at physiological maturity of soyabeans, the seed and plant is difficult to harvest and thresh, and if attempted will cause much damage to the seed. On the other hand, maize cobs may be harvested (but not shelled) at a seed moisture content of 25% to 30%, dried at moderate air temperatures (<35°C) and shelled when the seed moisture is less than 14% (see Box 5.6 for ways of determining seed moisture percentage). If the crop is to be mechanically shelled at the time of harvest, then the seed moisture content must be low enough to enable shelling but not too dry that the shelling action causes chipping and breaking of the seed. With maize, the ideal seed moisture for shelling is between 12% and 14%. If the moisture is below 11%, much damage will be caused by the action of mechanical shelling. If the seed moisture content is above 15%, physical damage of the seed through bruising and chipping may occur.

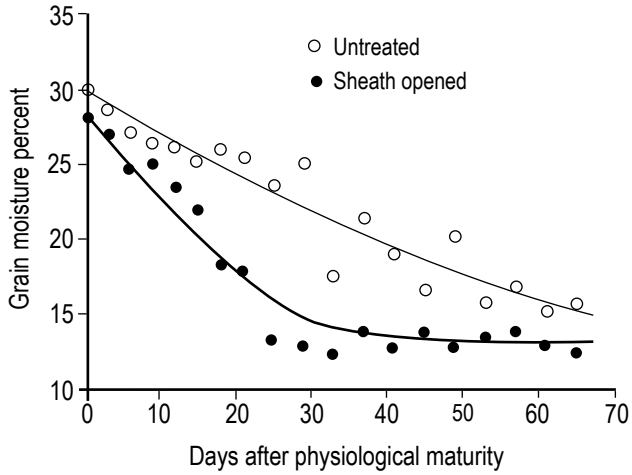


Figure 5.7 The decrease in the moisture content of seed remaining on the plants of maize with time after physiological maturity, where the cob sheath leaves were either opened or untreated.

Source: Data from the Agricultural Research Trust, (Encompassing Harare, Zimbabwe.)

Hand harvesting of seed maize is common and enables the elimination of diseased cobs at the time of reaping. Since this is a labor intensive process, it requires good management and supervision. Various methods have been devised to make it more efficient. The simplest is reaping cobs into sacks, which are carried out of the field by hand or on trailers. If the cobs are de-husked in the field, each worker should be able to reap 500 kg of cobs per day, whereas if there is a mechanical de-husker, and the reapers simply have to remove the cobs with husks on, then the reaping output may be increased to 1,500 kg per day per worker (Box 5.7). Reaping output may be increased if the cobs are thrown onto an adjacent trailer in the field, rather than being filled into bags. The trailer may be fitted with a hanging curtain in the centre of the trailer to prevent cobs being thrown right over the trailer. With the use of such a trailer system, labor output may be increased to 600 kg of cobs per day with de-husking, or 2,500 kg of cobs with the husk intact.

Box 5.6 Determining the seed moisture content

The moisture content of a seed sample is the loss in weight when it is dried in a constant-temperature oven under prescribed laboratory procedures (ISTA 2008). The seed is weighed before drying (the wet weight, W¬1) and again immediately after drying (the dry weight, W2)¬. The percentage seed moisture content is calculated as,

(W1 – W2) / W2 x 100

Note, the seed moisture content is calculated on the wet weight basis, so it represents the percentage of water in the original seed sample.

The simplest, but not always the most accurate, method of determining the seed moisture content is with the use of a portable electronic moisture tester.

Box 5.7 Maize cob weights

When using common 50 kg grain bags:

- a bag of de-husked cobs weighs ~40 kg
- a bag of cobs with husks weighs ~30 kg

Seed deterioration, germination and vigor

Seed quality begins to deteriorate after physiological maturity (Figure 5.6), and this is an inextricable process that cannot be stopped. Furthermore, seed deterioration is an irreversible process—bad seed cannot be turned into good seed. However, the rate of deterioration varies with the crop, and also within and between seed lots of a crop. And, through good management of the seed, the rate of deterioration may be slowed. Therefore, every effort must be made to reduce the rate of seed deterioration. Low quality seed will deteriorate faster than high quality seed, whereas high quality seed will store for longer than low quality seed.

Seed germination percent is defined as the percentage of seeds in a seed lot that develop within a given time into normal seedlings under optimum conditions. Abnormal seedlings may produce a radicle (root) and shoot, but are not capable of producing a normal seedling. Dead seeds obviously fail to germinate. A laboratory germination test establishes the maximum germination potential of a seed lot (ISTA 2008). The germination percent will be at a maximum at physiological maturity, or soon after, and will decline with time thereafter. The rate of decline is dependent on a number of factors, such as seed moisture content, environmental conditions and seed physiology. The proportion of normal seedlings, abnormal seedlings and dead seeds in a seed lot will vary with time after physiological maturity. As seed quality deteriorates, the number of abnormal seedlings increases. With further quality deterioration, the proportion of dead seed will increase.

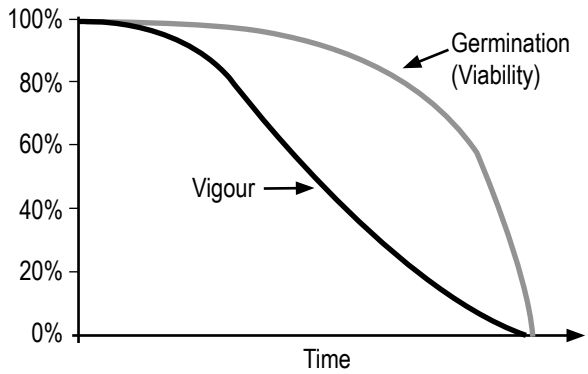


Figure 5.8 Schematic representation of the difference in seed vigor and seed germination with time after physiological maturity.

Source: Adapted from AOSA (1983).

Seed vigor is defined as those seed properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions. The seed vigor test therefore has the objective of providing information on the planting value of a seed lot in a wide range of environments and/or the storage potential of the seed (ISTA 2008). Seed vigor is therefore not equivalent to germination percent. Although the germination percent is relatively easy to determine, since it is evaluated under optimum conditions in a laboratory, seed vigor is more difficult to establish because it is not a single measurable property but a characteristic associated with rate and uniformity of emergence. A seed lot may pass the germination standard but have poor vigor when sown in the field under adverse conditions. Generally speaking, seed vigor deteriorates earlier and faster than seed germination percentage (Figure 5.8). This is often observed in farmers' fields when old seed is purchased that has passed the minimum germination standard, but fails to emerge satisfactorily when sown, because there may have been problems with soil conditions (poor seed-soil contact), the sowing method (too deep or shallow), insufficient or excessive rainfall, or high soil temperatures during establishment.

Shelling of seed

For maintenance of high seed quality, hand shelling of seed crops is ideal, but not always economically feasible. A worker may be able to hand-shell about 100 kg of seed maize, soyabeans or beans per day, but only 30 kg per day for groundnuts. A combine harvester might be able to harvest and shell 50 t per day or more. Many types of mechanical shellers are available for shelling crop seeds, but these vary in their impact on seed quality. Aggressive, abrasive, high-speed shellers will likely cause seed chipping and breakage. Mechanical damage to seed is due to abrasion and impact. Abrasion damage mainly affects the seed coat and results from seed rubbing against rough surfaces. Impact damage may affect the entire seed, and is a function of the force applied to the seed, usually resulting in seed chipping or cracking. Thus, mechanical shellers need to be operated at slow speeds with the concave adjusted as wide as possible to minimize the extent of seed damage. Contact edges in the threshing drum should also be rounded off and smoothed to minimize pounding of the grain. Mechanical shellers fitted with some method of seed cleaning to enable separation of the seed from extraneous matter, such as cobs, leaves and pods will ensure that raw seed is in good condition for entering the processing procedures.

Seed storage

Once shelled, the raw seed may be stored until processing, or enter directly into the processing system. Raw seed storage may be in bags or bulk, but if it is to be stored for more than a few days before processing, a number of conditions should be met (Box 5.8).

Box 5.8 Major reasons for seed deterioration in storage

- Low quality seed placed in storage
- Seed stored with high moisture content
- The first-in, first-out rule not followed, so that seed remains for too long in storage
- The kind of crop seed may be naturally prone to rapid deterioration, e.g., soyabeans, groundnuts
- The warehouse is not ideal, e.g., poorly ventilated, prone to heating, exposed to moisture penetration and/or insecure
- The environment is unfavorable for seed storage, i.e., too humid and hot

Source: Adapted from Attavar (n.d.).

Seed moisture and storage environment. No seed should be stored unless it is at a moisture content that is low enough to maintain seed quality. For most field crops, the seed moisture should be less than 12.5% for safe storage. However, the length of time that seed may be safely stored, even when it has low seed moisture content is dependent on the air temperature and relative humidity. The lower the air temperature and relative humidity, the longer the seed may be stored with minimal deterioration. As a general rule, if the relative humidity of the air is above 60 %, seed deterioration is likely to be rapid, as such conditions will increase the moisture content of the seed and encourage the development of diseases and storage pests. Ideally, seed should be stored in a ventilated secure shed protected from rain and heat.

Protection from storage insects. The seed should be fumigated and protected against storage pests. Fumigation is usually done with phosphine gas, either released from aluminium phosphide tablets or injected from hydrogen phosphine gas canisters. Fumigation is only effective in killing live storage pests. Thus, it should be supplemented with insecticidal grain protectants applied directly to the seed or sprayed onto the bag exteriors and building interior, to control re-infection.

Seed to be fumigated should be enclosed in an air-tight plastic sheet that will prevent the escape of the phosphine gas from the seed stack. Fumigation sheets should be polythene or polyester scrim of 250 to 350 g/m^2 mass. If the sheets are ultra violet (UV) light protected, they should last for three to four years, provided they are cared for properly. In particular, care needs to be taken to avoid damage from punctures and tears. Phosphine gas is slightly heavier than air and will therefore disperse downwards from the point of application, but will eventually spread to all parts of a contained area. Where phosphine tablets are used, these should be distributed at various places in the

bag stack or bulk bins, according to the recommended dosage, to ensure rapid and even gas dispersion throughout the seed.

The ideal conditions for phosphine fumigation are an air temperature of 21°C, a relative humidity of 60% and a grain moisture of 12%. Under such conditions, the seed should be exposed to the gas for at least five days, but the longer the better. The higher the air temperature, the faster the gas will be released from the phosphine tablets. If the air temperature is less than 15°C it is better not to fumigate as the gas generation rate is very slow.

Phosphine gas is **highly toxic** by either ingestion or inhalation. Therefore, operators must observe safety precautions, such as placing warning signs around the fumigated area, wearing suitable protective clothing and respirators, and prohibiting smoking and naked flames. Phosphine gas will corrode electrical equipment, while a mixture of phosphine gas and air is combustible and will explode if ignited. Therefore, electrical equipment should be well earthed to prevent sparking or static discharges.

Protection from rodents. Rodents may cause a tremendous amount of damage to seed. Losses might be reduced by storing seed in rodent-proof stores, ensuring bags in seed stacks are tightly bonded to prevent rodents from penetrating into the centre of the stack, and controlling rodent populations with poisonous baits and predators (e.g., cats, owls and falcons). However, the use of poisonous baits is usually antagonistic to the survival of predators, and therefore other strategies that do not rely on poison should be used.

Physical space for seed storage. Storing maize seed on cobs: Maize seed may be stored temporarily on the cob, either in loose stacks or in cribs, provided the grain moisture is less than 13%. Cribbed or binned ears of high moisture content can mould and be attacked by storage pests very quickly. The reason is that only at about 13% moisture content will the kernels and the cob be in moisture equilibrium (Table 5.5). At higher seed moisture contents, the cobs contain significantly higher moisture content than the seed, which will promote disease and insect growth. A key factor in cribbing maize on the cob is the width of the crib—the narrower the crib the better (2 to 3 m maximum), so as to allow sufficient natural ventilation through the cobs.

Table 5.5 Equilibrium moisture contents of grain and cobs on intact cobs.

Grain moisture, %	10	13	15	20	25	30	35
Cob moisture, %	9	13	18	33	45	52	56

Source: D.E. Maier (1996).

In some instances, seed may be dried on the cob. In this case, the cobs may be harvested at a grain moisture content of 25% to 30%, and transferred rapidly to an artificial drier, where air of moderate temperature (not greater than 35°C, cf. Tables 5.7 and 5.8) is used to dry the seed to 12% moisture. The density of maize cobs is about 480 kg/m3, which is equivalent to a seed density (on the cobs) of about 360 kg/m3. The densities of other crops are given (Table 5.6).

Table 5.6 The bulk density of the grain of some crops.

Crop	Bulk density kg/m3
Groundnuts (shelled)	640
Groundnuts (unshelled)	300
Soyabeans	720
Wheat	760

Storing seed in bags

Seed may be stored in bags for lengthy periods, provided the seed has a moisture content of less than 13 %, the storage conditions are favorable for maintaining seed viability (i.e., cool and dry), the seed is protected from storage pests, the bags enable gaseous exchange, and the bags are stacked in an orderly manner. Normally, raw seed is stored in bulk, or in 25 or 50 kg bags prior to processing or re-packing. Once seed has been processed, it is usually bagged in smaller packs (25 kg or smaller). Small packs of 10 kg or less are often combined into larger units, either by amalgamating into bags of 25 or 50 kg lots, or palletized into 0.5 or 1 t pallets. Where bags are to be stored in stacks, the following guidelines may be used:

25 kg bags:
Stack in 3 m x 3 m stacks, with 32 bags per layer (i.e., 0.8 t) and up to 20 layers high (total of 16 t). This stack will normally take eight bags width-wise times four bags length-wise.

50 kg bags:
Stack in 7 m x 7 m stacks, with 130 bags per layer (i.e., 6.5 t) and up to 32 layers high (total of 208 t). This stack will normally take 13 bags width-wise times 10 bags length-wise. Alternatively stack in 3 m x 3 m stacks, with 18 bags per layer, and up to 20 layers high (total 18 t).

Bags should be laid so that they are bonded together, with alternate layers laid cross-wise, to strengthen the stack. Sides should be inclined inwards to avoid any tendency for the stack to collapse. When starting a stack, the outer ring of bags is laid first, with a gap of about 2.5 cm between bags on the bottom layer. With each successive layer, the gap between bags is reduced, so that the width of the stack reduces with height. Lanes of about 1 m width should be left around the stacks to allow for stacking or dismantling, inspection, insecticide spraying, or covering with fumigation sheets. Stacks that have been laid well will have a density of about 0.65 t per m^3.

Bulk storage of seed

The advantage of bulk storage of seed is that it is more economic on storage space, since the density of seed in bulk is about 0.75 t/m^3. Furthermore, with well-constructed silos and conveyors there is reduced seed losses, less labor required for handling the seed, and the cost of storage bags is eliminated. Bulk storage of seed in steel silos is also easier to fumigate. The disadvantage is the high capital cost, although this may be offset over time with the saving in bags and handling. Silos should always be filled and emptied from the center to avoid excessive pressure building up on one side of the silo. If the drop height of seed from the intake to the bottom of the silo is more than 2 m, seed ladders should be employed within the silo to minimize seed impact damage. The angle of repose of seed of most field crops is about 25°C.

Seed drying

In most situations in Africa, seed is left to dry naturally in the field before harvesting and shelling. This is usually possible for summer-grown crops that mature in the dry winter period. However, it might be necessary to harvest the seed when it is above the safe storage moisture content and dry the seed artificially. Early harvesting and artificial drying of seed has the advantages of minimizing disease and insect infestation in the field, avoiding field losses from birds, rodents and theft, and it enables earlier processing and sale of seed. The disadvantages are that seed is more vulnerable to damage at high moisture content, poorly controlled drying may adversely affect seed viability, and artificial drying is costly. Maize and groundnuts may be artificially dried pre- or post-shelling, whereas most other field crops are dried after shelling or threshing.

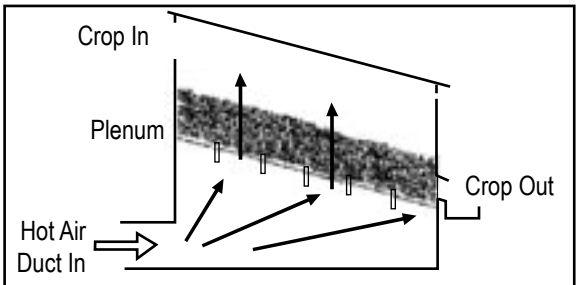


Figure 5.9 Schematic diagram of a batch drier with a sloping plenum to facilitate emptying.

(Diagram not drawn to scale).

The most common method of artificial drying of crop seeds is to force heated air through the cobs, pods or seed, to evaporate and remove the excess moisture from the seed. The batch-type of drier (Figure 5.9) is most suitable for seed, since continuous flow or re-circulatory grain driers involve a significant amount of seed movement, which might cause seed damage. In the batch drier, the cobs, pods or seed are stationary during the drying operation, and the crop is only moved during filling or emptying the drying bin. However, the drying pattern in batch driers may be uneven, with the unevenness increasing with depth of the crop. In batch drying bins, the seed at the bottom of the batch, closest to the incoming air, will dry down faster than the seed at the top of the batch. Evenness of drying may be improved by ensuring that the crop is clean, with a uniform depth of seed within the drier, and minimizing the depth of seed. The maximum depth of crop in a batch drier should be 1 to 2 m for raw seed, and 2 to 4 m for maize cobs.

The rate of drying depends on the air temperature, the relative humidity of the air and the rate of air-flow through the seed. Since seed is a living organism, the maximum air temperature for seed drying is less than that for grain drying (Table 5.7). The maximum air temperature also depends on the seed moisture content (Table 5.8), with lower air temperatures required at higher grain moisture contents. The equilibrium grain or seed moisture content is also a function of the relative humidity of the air (Figure 5.10) and the drying air temperature. Reducing seed moisture content to acceptable levels in environments with high relative humidity is difficult. Wherever the relative humidity of the air is greater than 50%, the equilibrium maize grain moisture content will usually be above 12.5%. Relative humidity levels above 65% pose a serious risk to long-term storage of seed, as the seed will increase in moisture content and become prone to deterioration, rotting and even sprouting.

Table 5.7 Maximum safe air temperature for drying seed of various crops.

Seed Crop	Air temperature (°C)
Maize	36
Wheat	43
Soyabeans	40
Groundnuts	35

The rate and pressure of the air-flow required depends on the crop, whether cobs, pods or seed are being dried, on the depth of crop and on the required rate of drying. For example, raw seed maize requires about three times the air pressure than cobs, because

of the greater resistance offered by the loose grain. The smaller the seed and the higher the bulk density, the greater is the resistance to air-flow through the mass of seed. Increasing the air-flow will increase the rate of drying, but will require more energy to generate the required air-pressure and more fuel to heat the greater volume of air flow.

The initial moisture content of the crop also influences the drying rate, because the rate of moisture extraction is not a linear function of moisture content. Less energy is required to remove moisture from wet grain than dry grain. In general, the drying rate for seed should not exceed 0.5% moisture removal per hour.

Table 5.8 The maximum drying air temperature for maize seed as a function of seed moisture content.

Seed moisture content	Maximum drying air temperature
Over 22 %	30°C
18 to 22 %	32°C
12 to 18 %	36°C

A number of air-heating systems are available, which may use a variety of energy sources (e.g., coal, diesel, cobs). The choice of system depends on the required air temperature increase, the volume of air to be heated, the availability of fuel, and the cost of the system. Solar drying may be possible in seed drying since the air temperatures used are usually less than 35°C. However, it is usual to use fossil fuel energy to heat air for seed driers. A number of fan options exist for creating the air-flow. Consequently, the design of a seed drying system is complicated and requires expert advice. When designing a drier, the following issues need to be considered with a design engineer:

- the kind of crop(s) and the type(s) of product (raw seed, cobs or pods) to be dried
- the quantity of product to be dried, over what time period
- the size and number of bins
- the filling and emptying of bins
- the location of the facility (accessibility, altitude, ambient air temperatures and relative humidity during drying)
- the fuel sources available
- the type of heat exchanger required
- the fan requirements

Seed Processing

Raw seed may not meet the physical standards of purity and germination required for certification. Furthermore, the size and shape of the raw seed may not have the uniformity required by farmers, while it might also be necessary to add chemicals and colorants to the seed coat as a means of identification, to protect the seed from insects and disease, and/or to enhance the performance of the seed at germination or during early growth. Finally, farmers usually want the seed supplied in certain convenient pack sizes. Seed processing or conditioning therefore involves:

- The separation of desired, good, healthy seed from inferior seed and impurities (extraneous matter and weed seeds) to achieve a specified standard of seed purity.
- Dividing good seeds into uniform grades of size and shape.
- Treating seed with chemical protectants, colorants and/or growth promoters.
- Packaging the pure, healthy seed into identified pack sizes.

Critical properties of seed

Certified seed must meet certain laboratory standards (Table 5.4). These may be summarized for maize as:

- Seed moisture content (less than 13 %)
- Physical purity (99 % pure seed of variety with less than 3 % total defects)
- Size and shape, as per specifications and tolerances appropriate to the market
- Genetic purity, determined certification standards
- Germination capacity (minimum germination 90 % by count).
- Seed health (no diseases or insects).

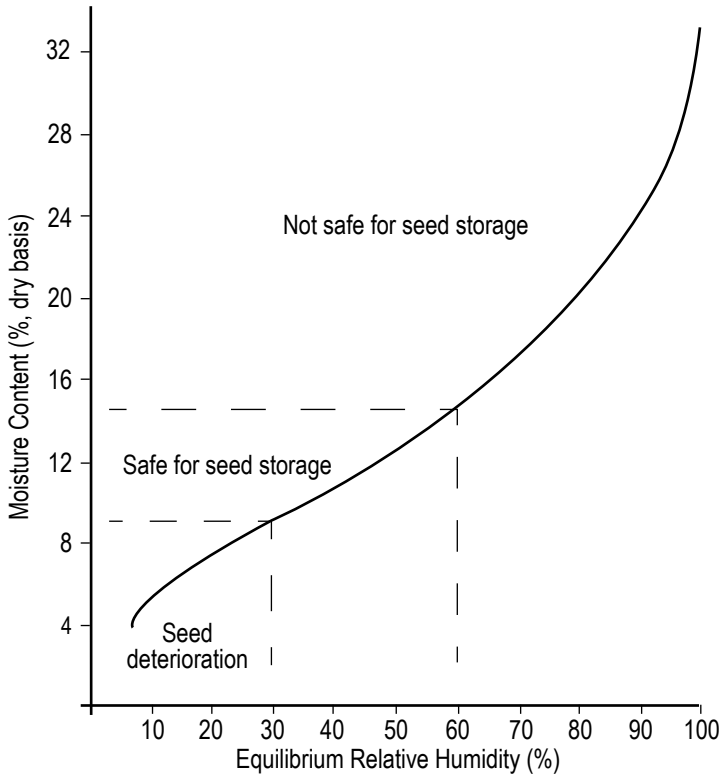


Figure 5.10 The equilibrium maize grain moisture content as a function of the equilibrium relative humidity of the air.

Source: Adapted from Chen and Tsao (1994).

Sequence of seed processing

Seed processing or conditioning involves a number of mechanical steps to take raw seed through to the quality standard required and expected by farmers (Figure 5.11). Not all steps may be required, depending on the type of crop, condition of the raw seed and the requirements of the farmer. After shelling, the very minimum processing required, especially for crops such as soyabeans and beans, is to clean the seed to remove very small seeds, extraneous matter and weed seeds, followed by bagging. For OPV maize seed, a similar process may be followed, except that the seed is usually treated with chemicals prior to bagging. OPV maize seed should not be graded into different seed sizes, as this is a selection process which might affect the genetic composition of the variety. Hybrid seed maize is usually taken through all the steps, including seed grading, since hybrids have a fixed genetic make up and are of higher value. Generally speaking, the number of stages used in seed processing should be kept to a minimum, for efficiency sake. However, in some cases, more steps—not illustrated in Figure 5.10—might be required.

Machines exist to de-awn or de-husk crops like wheat, oats and barley, scarify seed with hard seed coats, length grade maize seed for certain planters, weight separation with a gravity table or aspirator to remove undesirable seeds (such as diseased seed), and color separators to remove wrong-color seed. Each additional process requires extra time and cost, but may be justifiable if it improves the physical quality of the seed.

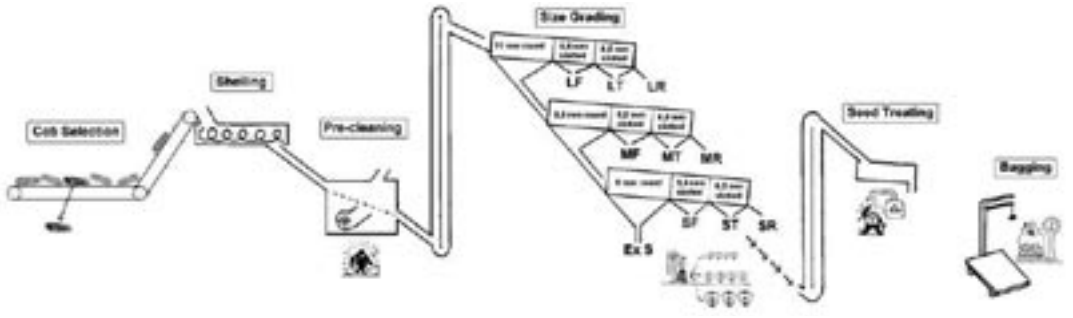


Figure 5.11 Stylized sequence of the main processing stages for hybrid maize seed.

Dimensions of seed

Seed is usually sold by weight, but in some instances, seed might be sold by kernel count. In either case, the seed weight is an important characteristic for seed producers and farmers (Table 5.9 and 5.10), as it determines the seeding rate. In a given mass of bulk seed, there will be a certain number of seeds depending on the average seed mass. It follows, therefore, that there will be more small seeds than large seeds in a given mass of seed. Usually, seed is sold by mass in Africa. Since viable seed, regardless of size, will germinate and establish a plant under optimal conditions, farmers may prefer to buy small seed, so that a bag of seed will plant a larger area of land. Conversely, where seed is sold by kernel count, the pack mass will depend on the average seed size, and farmers would need to purchase a certain number of bags to plant a particular area of land, as determined by the plant population.

Table 5.9 The average seed size, number of seeds per kg, common plant population and seed rate of various crops. Actual values will depend on variety and growing conditions.

Crop	Thousand seed mass (g)	Number of seeds per kg	Plant population per ha	Seed rate (kg/ha)
Maize: Three-way hybrid & OPV	520	1,923	44,000	23
Maize: Single-cross hybrid	380	2,632	50,000	19
Soyabeans	220	4,545	320,000	70
Groundnuts: Spanish	300	3,333	300,000	90
Groundnuts: Virginia	600	1,667	150,000	90
Cowpeas	100	10,000	250,000	25
Field Beans	450	2,222	180,000	81
Wheat	45	22,222	2,000,000	90

Seed companies may provide seed weight information for such crops as soyabeans and wheat, but if not, farmers need to determine the average seed weight in order to sow the right amount of seed to achieve the desired plant population, taking into account the germination percent and expected field losses.

Box 5.9 Reasons for maize hybrid seed size grading

Seed size grading of maize hybrid seed is useful for the following reasons:

- It improves machine planting of crops, since planter metering devices are usually designed for particular seed sizes.
- Hand planting is easier with uniformly-sized seed, as the seed is handled better than when the seed sample is composed of mixed-sized seeds.
- Uniformly-sized seed is more appealing to customers, and it enables customers to choose the size of seed required for their planting conditions.
- The size of seed has a significant effect on the seed rate per unit area.
- If seed is sold on a kernel count basis, uniformly-sized seed makes it easier to establish bag weights.

Note: Seed of open-pollinated maize varieties should not be size-graded, as this may impose artificial selection pressure on the genetic population, and affect the long-term performance of the crop.

Maize is usually the only crop that is divided into different seed grades or size classes (Table 5.10) as this has some benefits to farmers, particularly those who sow with machines (Box 5.9). The definition of these seed grades, as used in Zimbabwe, is illustrated (Figure 5.12). The width of a seed is classed into either Large, Medium or Small grades, differentiated by round-holed screens of specified diameters (Figure 5.13). The thickness of a seed is classed into either round, thick or flat grades, differentiated by slotted screens of specified widths (Figure 5.14). Thus, there are at least nine seed

grades, but there may be a further division into extra-small seed for some varieties. Furthermore, in some markets, such as South Africa, length grading may also be carried out, particularly where farmers are sowing with certain kinds of machines. Although countries may differ in their grading definitions, screen sizes and number of grades, the principle of length, width and thickness remains the same.

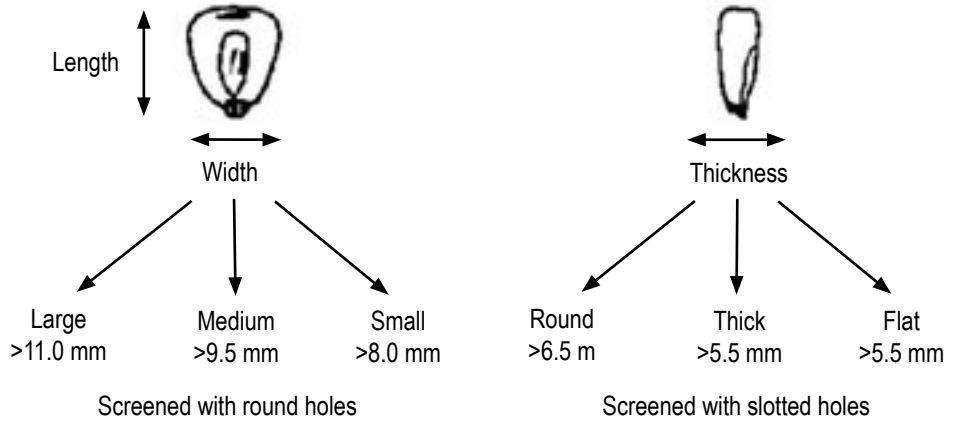


Figure 5.12 The definition of maize seed grading, according to the Zimbabwean grading system based on hole sizes of round or slotted screens.

Table 5.10 The proportion of seeds in each seed grade class.

	Percent seeds			Seeds per kg			Thousand seed mass (g)		
Seed grade	**OPV**	**TWH**	**SCH**	**OPV**	**TWH**	**SCH**	**OPV**	**TWH**	**SCH**
Large round	0.3	3.0	11.3	1,667	1,667	2,123	600	600	471
Large thick	0.3	1.5	8.6	1,538	1,695	2,381	650	590	420
Large flat	0.8	7.6	9.6	2,000	1,770	2,714	500	565	368
Medium round	3.5	21.1	26.7	2,143	1,656	2,620	467	604	382
Medium thick	8.1	10.5	17.7	1,863	1,896	2,958	537	528	338
Medium flat	38.2	50.0	21.4	2,406	2,049	3,173	416	488	315
Small round	5.9	3.3	1.4	2,466	2,108	3,448	406	474	290
Small thick	7.5	1.8	1.9	2,597	2,162	3,896	385	463	257
Small flat	31.7	0.9	0.8	2,899	2,778	6,061	345	360	165

Note: This also includes the corresponding seed numbers and seed weights of a typical maize open-pollinated variety (OPV), three-way hybrid (TWH) variety and single-cross hybrid (SCH) variety. The total percent of seeds for each variety may not add to 100 % because the extra small seeds are not included in the table.

Seed grading machines separate seeds according to width first, thickness second, and if necessary, length last (Figure 5.15). In Africa, length grading is rare. For seed width grading, the first screen has large (11.0 mm) round-holes. Seed that fails to pass through the screen is classed as large seed. The medium-sized seed passes through the 11.0 mm screen but passes over the 9.5 mm round-holed screen. The small-sized seed passes through the 9.5 mm screen but passes over an 8.0 mm round-holed screen. Any seed that passes through the 8.0 mm screen is classed as extra-small.

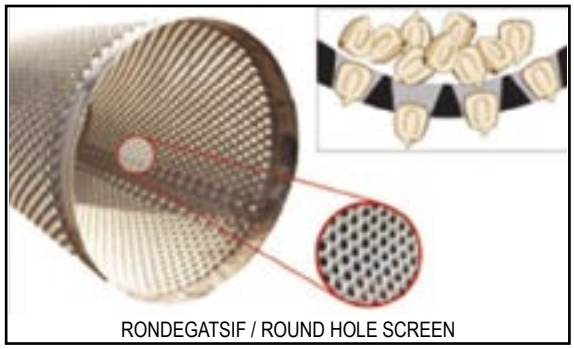


Figure 5.13 Illustration of a round-holed screen used to separate seed according to width into large, medium or small sizes.

Once the width classes of the seed have been screened, seed of each width class passes onto slotted screens. Seed that fails to pass through a 6.5 mm slotted screen is Round seed. Seed that passes through the 6.5 mm screen but fails to pass through a 5.5 mm slotted screen is classed as Thick seed. Flat seed is that which passes through the 5.5 mm slotted screen.

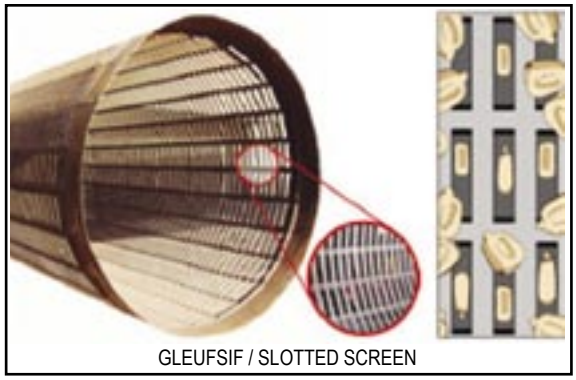


Figure 5.14 Illustration of a slotted screen used to separate maize seed according to thickness into round, thick or flat sizes.

Grading efficiency and effectiveness is greatly affected by the cleanliness of seed entering into the grader, the rate of seed delivered to the grader, the speed of rotation or movement of the screens, the screen area and the slope of the screen. The faster the seed moves through a seed grader, the less effective will the size differentiation be.

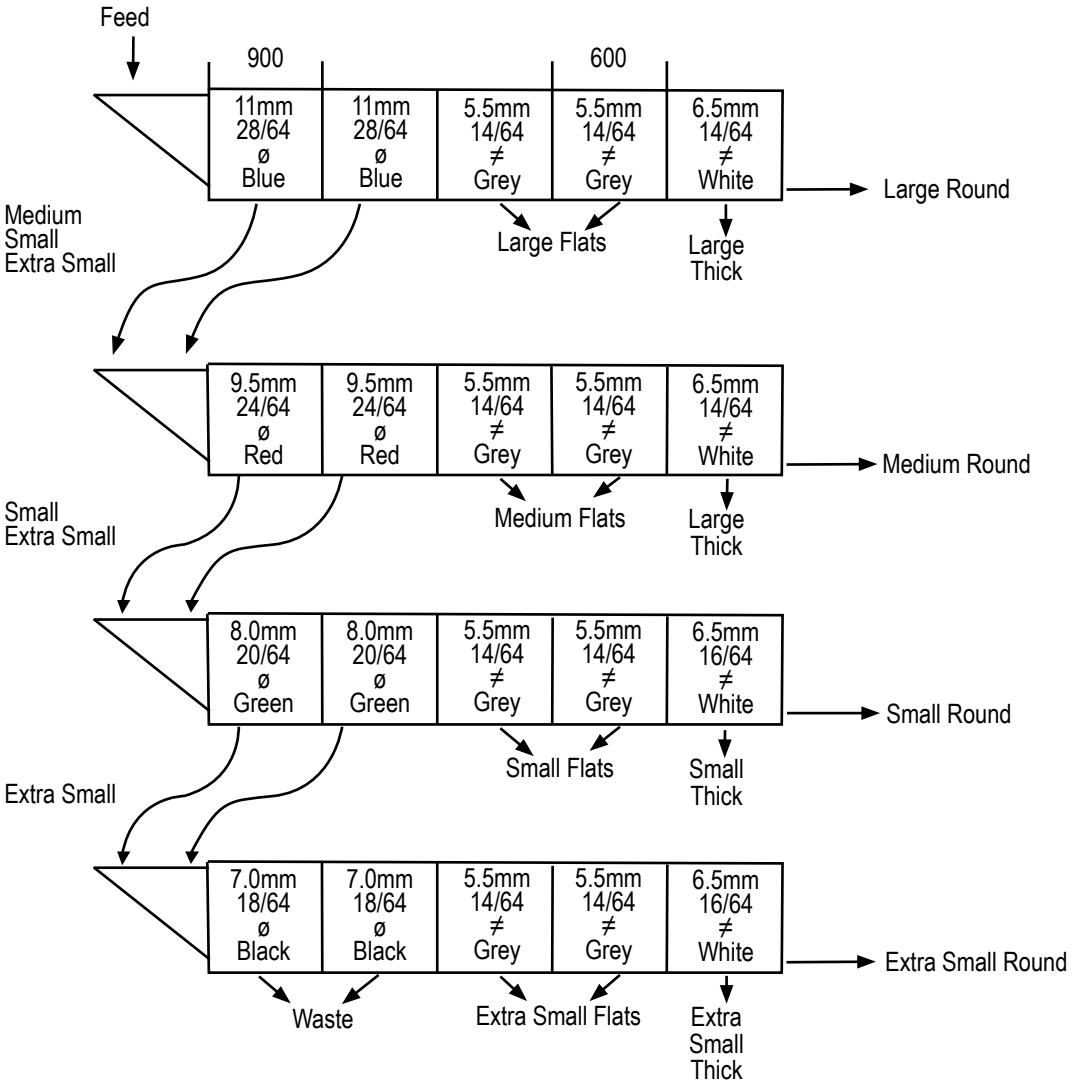


Figure 5.15 Schematic representation of the flow of seed through a seed grading tower, showing the various grades of seed screened out according to screen hole shape (Ø = round holes; ≠ = slot holes) and hole width, according to the Zimbabwe grading system.

Source: Grain and Seed Tech (Pvt) Ltd, Harare, Zimbabwe (2009.)

Pre-cleaning

Raw seed will contain varying amounts of extraneous matter, damaged seed and weed seeds depending on production and harvesting methods. The pre-cleaning operation attempts to improve the seed physical purity. The better the pre-cleaning, the better all subsequent operations will proceed. The most basic method of pre-cleaning is by hand, either by hand-picking unwanted material and seeds from the true seed, or with the use of simple winnowing baskets.

Mechanical pre-cleaners use screens and air to remove unwanted material. Generally, two screens are used: a large round-holed screen to remove large particles, such as trash and crop residues; and a small round-holed screen to remove small, heavy particles such as weed seeds, small crop seeds and sand. The screen sizes are chosen to correspond appropriately with the seed size range of the crop. Aspirated cleaners use an air stream to remove light "floatable" particles from the seed. The efficiency of pre-cleaning is affected by:

Seed characteristics. Seed size distribution. Screen perforations must be larger and smaller than the normal upper and lower size range, respectively, of the seed sample.

- Seed moisture content higher or lower than the optimum may affect extent of seed damage.
- Adhesiveness of grain. Seed must be loose and flow easily.
- Flow rate. Movement of seed over screens must be slow enough to allow proper separation of seed from unwanted objects.

Screens—size and shape of perforations.

- Distances between perforations. The closer the perforations and the more perforations there are, the better the screening efficiency.
- Clogging control. Every perforation that is blocked leads to lowered efficiency. Thus the cleaning device on the screens must be effective.
- Length and shape of screens. The greater the screen surface area, the greater the screening capacity and efficiency.
- Inclination (slope) of screens and movement (agitation) affects the movement of seed over the screen. The greater the slope, the quicker the grain moves through screens, and the less efficient will be the screening.
- Depth of seed and uniformity of seed over the screen must ensure maximum contact between the seed and the screen.
- Damage of screens often occurs when they are put in and taken out.
- Because of vibrations, bolts can become loose, which will cause much damage, so ensure frequent maintenance of machines.
- Abrasiveness of seed and other material can change perforation dimensions and therefore screening efficiencies. Therefore, frequent checking of screen perforation dimensions is necessary.

Air separation.

- The effect of an air current on a particle or seed depends on its shape and specific weight.

- Separation itself is based on the ability of the particle to float in the air current.
- Upward force of the air current causes flotation, and the ability to suspend particles depends on the velocity and volume of air.
- Downward force (gravity) is used to keep wanted seed.
- The air current should be directed through seed. The material should flow constantly and in a uniform layer over the air stream. Non-uniform distribution of either the air supply or material flow will reduce effectiveness of air separation, because air will always take the easiest route.
- The maximum air volume should be used that does not remove wanted seed.

Feeding and operation of machines.

- A uniform, even flow of material must enter machines at a rate that the machine can adequately cope with. A pre-machine storage bin, which acts as a buffer, and a vibrator-feeder, aids this process.
- Generally, when adjusting machines, only adjust one setting at a time.

Gravity separation

Once seed has been pre-cleaned and separated according to size (width, thickness and length), it may still contain unwanted grains of the same size but which differ only by their specific weight. The specific weight is the weight of the particle itself. The unwanted grains may be stones, diseased grains, and seed of other crops, all of which have the same size (volume), but differ in mass. These similar-sized grains differing in mass may be separated on a "gravity table" that uses a combination of pneumatic and mechanical action. The machine consists of a table that has an inclined (3 to 4°)C porous surface which oscillates.

Seed is fed in a continuous and regulated manner onto the lowest corner of the table, and it spreads out evenly over the table by the oscillating action. Air is blown up through the seed, which separates the grain into horizontal layers, with the heavier seed at the bottom, and the lighter grains suspended at the top. The heavier seed is in contact with the oscillating table surface, which mechanically moves the seed to the top end of the table, where it is discharged through outlets. The lighter seed, which is in suspension, is not affected by the oscillating table surface and so moves laterally downwards over the heavy seed to the lower side of the table, from where it is discharged through outlets.

The seed is thereby separated into different fractions and qualities. The very heavy particles might be stones, while the very light particles might be crop residues, diseased

grains, or seeds of other species. The good seed, of a particular specific weight can therefore be captured in the appropriate outlets.

The management of the gravity table requires much skill and experience. This is because the gravity table has a number of components—the type of porous table cover, the longitudinal and lateral inclination of the table, the cycle and intensity of oscillation and the pressure and distribution of the air current. The gravity table is also a fairly slow process, and may often be the "bottle-neck" in a seed processing line. It is not always a required process, especially if the raw seed is clean, uniform, and free of defects and disease. However, if a gravity table is to be used for maize, it is best done after pre-cleaning and grading. Nevertheless, in advanced seed companies, it is usually an integral part of processing to ensure that the very best physical seed quality can be achieved.

Bucket elevators and conveyors

Bucket elevators are much gentler on seed than augers, and should be used in preference. Augers tend to crack and bruise seed. The faster the speed of bucket elevator action, the greater the volume of seed moved, but the more likely will damage occur to the seed. Likewise, conveyors are an efficient way to move seed from place to place. In the design of elevators and conveyors, care should be taken that seed is not dropped from one machine to another over a large distance, since the force of impact on a hard receiving surface may cause seed damage. Impact damage to seed may be immediate causing cracks and splits, or latent through damage to embryos. Both kinds of damage reduce viability and vigor of the seed. If seed must fall a long distance (> 2 m), for example into silos, it is advisable to install grain ladders or spirals to reduce the height of the fall or cushion the seed drop.

Feeding of machines

Seed processing machinery works best when they are supplied with a constant flow of seed that matches the capacity of the machine. Thus, each component of a seed processing line should be fitted with a supply hopper to buffer the incoming seed flow, and at the point of feed into the machine, a regulatory mechanism installed to provide a regulated and continuous flow of seed. Options include gravity feed with an adjustable gate, a volumetric oscillating bucket, a feed roller, or a vibrator feeding mechanism. The latter system is gentle on seed and the most precise.

Seed treatment

Seed may be treated with various kinds of chemicals to improve its appearance (e.g., with dyes), protect it from pests, diseases and weeds (with insecticides, fungicides and

herbicides, respectively), and/or to add performance enhancing products (e.g., growth regulators and nutrients). The aim of any seed treatment is to obtain uniform chemical distribution over the seed coat of every seed at the correct chemical dosage. This is no easy task, since the chemical dosage rate may be as little as 50 µg per seed in the case of wheat, or 1 mg per seed in the case of maize. The chemicals therefore have to be diluted and applied with special machinery that ensures thorough mixing of the seed and chemicals.

Seed treatment may increase the moisture content of the seed at the time of application, particularly if the chemicals are diluted with too much water. In some cases, the seed may need to be dried to a safe moisture content before packaging. Seed treatment will affect the mass and flowability of the seed, which may be a factor to consider in processing, packaging and machine sowing. Seed treatment also involves the use of chemicals that may be toxic, particularly in the concentrated formulation. Consequently, safety precautions must always be observed during seed treatment.

There are various ways of treating seed:

Seed dressing — the seed is not completely covered by the chemical(s), and the mass increase from the chemicals is very small (<2 %). The chemical, usually mixed with water and possibly with a sticker, is applied to the seed in a mechanical mixer for a short period of time. The quantity of slurry, the mixing time and the nature of the seed determines the coverage.

Seed coating — the seed is completely covered with the chemical(s). The mass increase is in the order of 2 to 5 %. The method of mixing involves a combination of chemical application, usually in small droplets, combined with mechanical mixing to ensure near total coverage of the seed.

Seed film coating — the chemical forms a complete sealed layer over the entire seed.

Seed pelleting — the seed is covered by a layer of chemicals that completely encases the seed, resulting in a significant increase in mass and dimensions of seed. Seed pelleting is used for very small seed to increase the seed size for ease of sowing, or to apply certain nutri-chemicals.

The key factors for seed treatment are:

- **Coverage,** i.e., the evenness with which each individual seed is covered with chemical.
- **Distribution,** i.e., the uniformity of chemical distribution throughout the seed sample. Depending on a number of factors, seeds within a seed lot may have differing amounts of chemical applied. Seeds with a low amount of chemical will not be adequately treated, whereas seed having too much chemical may show phytotoxic effects with some chemicals.
- **Overall seed loading,** i.e., the total amount of chemical on the seed should be according to the specified dosage rate.

The way to achieve optimum seed treatment depends on:

1. The correct dilution and application rate of the chemical (i.e., chemical to water ratio, and the amount of chemical applied per unit quantity of seed). The dilution rate must be increased for:
   - absorbent seed,
   - seed with a rough surface,
   - seed with a low moisture content,
   - small-sized seed,
   - dirty seed, and
   - poor mixing conditions.

   Any water applied to seed will increase the seed moisture content, which may require the seed to be dried if the resultant seed moisture is higher than the safe seed moisture. Usually, on maize seed, the slurry application rate should be less than 10 mL/kg (i.e., 1%) in order not to increase the seed moisture content significantly. Too much liquid applied to seed may also cause the seed to stick together or even initiate the germination process as the final seed moisture content will increase (Figure 5.16). Too little liquid will not provide sufficient coverage of the seed, result in poor distribution of the chemical through the seed lot, or both.

2. The mixing time. The longer the mixing time and the more frequent the contact between chemical and seed, the better will be the seed treatment.

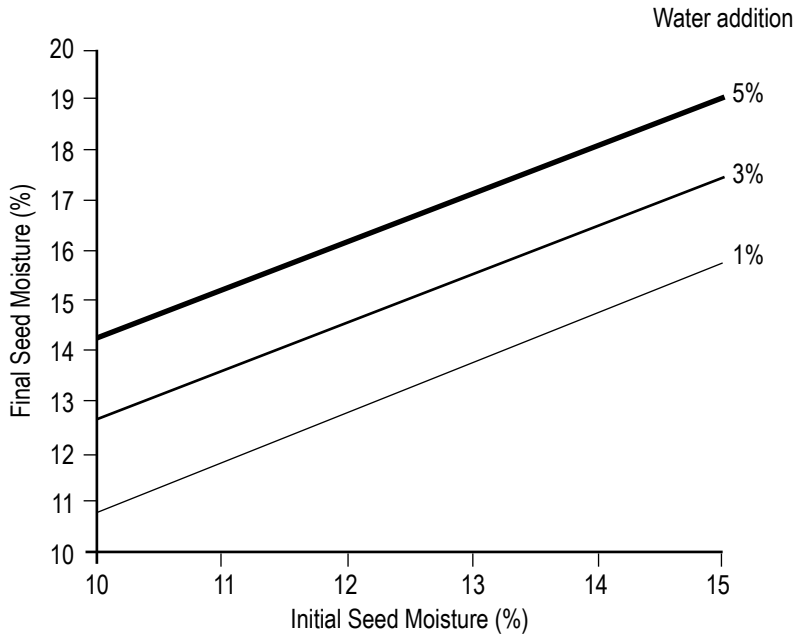


Figure 5.16 The effect of application of water to seed (i.e., volume of water as a percentage of seed mass) on the final seed moisture percentage, as a function of the initial seed moisture percentage.

3. Chemical handling guidelines.
   - Store chemicals in a secure storeroom that is cool and ventilated.
   - Maintain a stock register to monitor chemical issues and use.
   - Mix chemicals with clean water.
   - Once the chemical has been diluted, ensure continuous agitation.
   - Use mixed chemicals within 12 hours.
   - Check the calibration frequently to ensure the correct dosage.
   - Wash equipment after use.
   - Observe chemical safety precautions.
   - Longer seed treating times give better coverage and distribution.

4. Calibration and management of seed treaters.
   Two types of treaters are generally used in a seed processing plant.
   a. Batch treater (e.g., rotating drum or concrete mixer)
      - These are easy to calibrate, since a known quantity of seed is applied into the treater to which a pre-determined quantity of chemical solution is applied.
      - A measured amount of seed is poured into the treater, say 50 kg of seed.
      - The right amount of chemical solution required to treat the 50 kg of seed is measured and applied into the treater.

- The seed and chemical solution are agitated for a pre-determined time to achieve good coverage and distribution (beware of over-agitation that may cause seed damage).
- The dilution rate of the chemical may have to be adjusted (i.e., to change the solution application rate) to achieve satisfactory coverage and distribution.

b. Through-flow system (e.g., continuous flow treater)
- Start the machine while the chemical is closed off and record the time taken to catch a given mass of seed, say 50 kg, at end of the trommel. For example, it takes one minute to catch 50 kg of seed.
- Assuming the recommended dosage rate is 8 mL of chemical solution per kg of seed (i.e., 0.8%), 50 kg of seed would require 400 mL of chemical solution (i.e., 50 kg x 8 mL/kg).
- While the machine is operating, open the chemical applicator for one minute and collect the chemical solution in a measuring cylinder. If the volume of chemical solution collected is less than 400 mL, open the valve wider, or if the volume of chemical solution collected is more than 400 mL, close the valve slightly. Make adjustments until the right amount of chemical solution is released in the given time.
- If the chemical solution control system is a valve, it will be necessary to calibrate the equipment daily before use because the valve cannot be opened to exactly the same position on each occasion, and some blockages that restrict the flow of chemical might also occur.
- During operation of the equipment, monitor the total amount of seed treated and the volume of chemical applied to check the application rate, allowing for a ±5 % variation from the recommended application rate.
- Where a colored dye is applied with the chemical, the color of the treated seed will be a relatively good visual indicator of the application rate of chemicals.

Seed packaging and labeling

Farmers desire clean, quality assured seed of their preferred variety in a pack size that is affordable, transportable and convenient for their size of operation. With field crop seeds, a large-scale farmer will usually prefer pack sizes of 25 kg or more (e.g., even 1 t bulk bags), because they sow large areas with machines. Conversely, the small-scale farmer may prefer pack sizes of 10 kg or less, because of small field sizes. For maize, 25 kg is convenient because it will plant about 1 ha of land, depending on seed size. Likewise, 10 kg of maize seed will plant about 1 acre (0,4 ha). Since the largest seed market is amongst smallholder farmers, most seed companies in Africa package maize seed into small packs of 2 to 10 kg.

Some seed companies pack maize seed according to kernel count. Since the normal plant density for maize is in the order of 45,000 plants per ha in high potential areas, seed bags may contain 50,000 kernels. For smaller areas, packs may contain 20,000 kernels or 10,000 kernels. A problem that might arise when packing seed according to kernel count is that different kernel sizes do not weigh the same nor have the same volume. Thus, different pack sizes might be required to pack the same kernel number, depending on average kernel weight.

When considering seed packaging, a seed company must decide not only on the pack sizes and the proportion of seed to pack in each pack size (this should be determined by marketing surveys), but also on the packaging material, and the required packing machinery.
The factors that affect the choice of packaging material are:

- The exposure of the packaging to ultraviolet light (sunlight) can cause deterioration of some materials, particularly plastics, if they are not protected against ultraviolet light deterioration.
- Strength of material. Seed packs may be transported over long distances by various methods, some of which might entail rough handling, requiring durable material.
- The packaging machinery available. The simplest packaging system is the filling of open-mouthed bags with volumetrically measured seed and closing with a sewing machine. This is possible with cloth, jute and polyweave bags but not plastic. Plastic bags need to be heat sealed.
- The quality of presentation of the package. Markets differ in their requirements for presentation, but generally, the smarter and more attractive the packaging, the more appealing will it be to the buyer, but the more expensive it will be.

Types of packaging material:

- Cotton cloth, usually light-weight, single-thread weave, may be used for small packs. These are usually open-mouthed, seamed bags, closed by stitching machines or by hand, using twine. Cotton is porous, has a high moisture transmission rate, but is relatively strong.
- Jute sacking may be of various sorts ranging in strength and weight. They are usually open-mouthed, seamed bags that are closed by stitching machines or by hand, using twine. Jute is porous, has a high moisture transmission rate, but is relatively strong and cheaper than cloth. Jute bags have good stacking characteristics, and may be stacked to a considerable height if good stack-building techniques are used.

- Paper, either heavy duty Kraft quality, with or without wet-strengthening, or Sulphite paper, which is clean and bright, with excellent printing qualities. Very small packs for vegetable seeds are usually made from Sulphite paper, while for larger packs, multi-walled paper sacks of Kraft quality are usually used. All these packs are usually glued or seamed open-mouthed bags that are closed with stitching or glue. Paper has a relatively high moisture and air transmission rate, unless lined with polythene. Plain paper has poor wet-strength, but this may be improved with coatings or laminations. Paper bags for 10 or 25 kg-sized packs may be sufficiently strong for light handling, but not for rough handling.
- Plastics, either polyvinyl chloride (PVC), polythene (PE) or polypropylene weave are most widely used in the seed trade. Polythene film is normally transparent and offers an excellent surface for printing, but should have colorless UV protection for longer storage life. Polythene film may be used for seed packs up to 10 kg, provided a sufficiently thick gauge is used. The packets should be perforated with small holes to facilitate air movement in and out of the bag. Polythene film usually comes in flat rolled sheets, which are heat sealed during packaging. Polythene bags may be prone to breakages with rough handling. Polypropylene weave, which may be lined with polythene, may be used for most pack sizes from 5 kg upwards, and are strong and durable. Plastic stacks are prone to slip when stacked because of their smooth surface.
- Aluminum foil with various kinds of laminations and sealed tins are used for high value seeds, such as vegetables.

Packaging equipment. The two means of packing seed are volumetric or mass systems. The volumetric system is designed in such a way that the volume of seed is equilibrated to a mass of seed. This may be as simple as a "measuring jug" manually filled with seed and poured into the bag. More sophisticated systems are filled and emptied mechanically, either manually or automatically from an overhead seed reservoir. The main precaution on volumetric packers is that they must be regularly calibrated, because the volumetric container may change in volume with use, or the bulk density of the seed may change according to variety, seed grade, and seed lot. It is also important that the volumetric container is filled to the right capacity and completely emptied on each cycle. It is common to over-fill seed bags using a volumetric bagging system so that the average mass of the seed bags slightly exceeds the specified seed bag mass.

Mass systems may be either manual with a scale, or automatic with a system of filling the weigh bin from an overhead seed reservoir, and emptying the seed into bags. Weigh

systems are normally more accurate than volumetric systems, but they also require regular calibration and check weighing.

Bags that are filled by either the volumetric or weighing system may be supplied to the machine manually or automatically. Simple volumetric manual systems, like the measuring jug, are slow and inefficient. Improvements in efficiency are made as increasingly sophisticated mechanical and automatic systems are incorporated into the packing process. The first step in improving efficiency from the "measuring jug" is to have an overhead seed reservoir that feeds the seed by gravity into the volumetric or weigh bin, which may be filled and emptied manually by use of handles. Bags are supplied to the outlet funnel by hand, filled, and passed on to the bag sealing machine. Highly mechanized plants are able to do the whole process with little assistance from labor.

Labeling. Seed bags require specific label information, which usually includes the crop, variety name, class of seed, seed grade (if graded), germination and purity results, and lot number. These requirements are part of the seed regulations, and may differ from country to country. All other information on a seed bag is the prerogative of the seed company, but forms an important component of the marketing strategy of the company. Seed companies will also label the seed with conditions of sale and liability exclusion statements. If the seed has been treated with chemicals, this should be indicated on the packaging, especially noting that the seed should not be consumed as food or feed.

Seed machine cleaning and maintenance

Seed processing machines may be a source of admixture and consequent quality deterioration if they are not thoroughly cleaned between crops and varieties. Thorough inspection of the processing line should be done between seed lots, to ensure that no mixture of seed will occur.

Regular maintenance of seed processing machinery is required. All machines usually come with operator manuals and maintenance schedules, which should be adhered to. With many machines, especially cleaners and graders, there will be various screen options that will be used for different crops and varieties. When not in use, these screens should be stored in a safe place, and when changing screens, care should be taken not to cause damage to the screens or the machine. Moving parts are usually lubricated, and regular application of lubricants will ensure that maximum life-span and efficiency of the machine will be attained.

The keeping of a maintenance and breakdown log will help to ensure regular maintenance and enable analysis of those components of the processing line that are wearing out rapidly or breaking down frequently. When a machine breaks down, it is important to determine the root cause of the problem, whether purely mechanical failure or operator induced.

Seed plants do not usually operate for the full period of a year. Thus, during breaks in processing activities, and at least once a year, the seed processing line should be thoroughly overhauled.

Safety

Safety must be an integral part of seed processing.

- Mechanical safety. Machines should be fitted with emergency shut down switches. Dangerous moving parts should be encased in protective cages.
- Electrical safety. Operators need to be protected against electric shock, and precautions followed when maintaining electric components.
- Dust and waste control. Seed processing generates dust, which should be removed by air-extraction ducts. Cleaning plants also produce unwanted residues, which can be a fire hazard or become an environmental waste problem.
- Hazardous chemical safety procedures must be followed during fumigation and seed treatment.
- Vehicle safety. Movement of seed around the plant with tractors or fork-lifts may cause accidents.
- Seed storage safety. Care must be taken with seed stack construction, while silos should not be entered without due precautions being taken.

Investment in machinery and equipment

The very basic equipment requirements for a seed business comprise a seed moisture meter, weighing scale, seed cleaner, seed treater, and bagging system. This might be as simple as a screen trommel, a rotating drum treater, a volumetric measure and a hanging balance. However, such a simple system would only be sufficient for a seed company producing a few hundred tons of seed. As production increases to 1,000 t or more, investment in more efficient and sophisticated processing equipment will be required.

Seed processing equipment comes in a variety of types and capacity. The meaning of the term "capacity," when applied to the seed processing equipment depends very much on the composition and type of material going into the processing line and on the quality

expectations of the product coming out of the machine. Poor quality raw seed and high quality output expectations will lower the capacity of the machines. Likewise, the type of crop will have a marked influence on output. Processing maize or wheat may result in quite different output capacities on the same machine.

Need for new equipment
When considering the purchase of seed processing machinery, the following points need to be taken into account:

- Is the current processing line being used in an optimal manner? Can improvements in efficiency be achieved through better organization, better machinery management or by improving the quality of the raw seed?
- Should new machinery be purchased or will reconditioning the present machinery suffice?
- Can the increased processing needs be out-sourced?
- What components are required for increasing the capacity of the processing plant?
- Will investment in new seed processing equipment require additional shed space, civil works, electrical connections, and personnel development?

Profitability

- What are the costs of buying, operating and maintaining the new equipment?
- Will the new equipment be used throughout the year?
- Could the new equipment be used to contract process other commodities?
- What financing options are there for purchasing new equipment?
- Could you save up sufficient money to pay cash?

Warehousing

Seed is a bulky and living commodity and storing and regulating seed movement into and out of the store is a daily business in a seed company (Box 5.10). Warehouse space is required for storing the raw seed upon delivery, and for storing the seed that has been processed and is ready for dispatch. Separate warehouses are needed for the different types and classes of seed, partly for security but also to minimize possibility of mixtures occurring. Factors to consider are:

Warehousing structure
Seed warehouses need to be spacious, well ventilated, with a leak-proof roof and an impervious floor. Preferably, the sides of the warehouse should be enclosed to reduce rainfall penetration and to provide security.

The space required in a warehouse will depend on the amount of seed to be stored. Maize seed stored in bulk has a density of about 750 kg/m3, while seed stored in bags has a density of about 650 kg/m3. A bag stack of 3 m x 3 m x 4 m will contain up to 20 t of seed. Allowing for corridors between stacks, a shed 9 m wide by 18 m long could hold 160 t seed.

Box 5.10 Storekeeping tips

Seed companies not only maintain large stocks of seed, but also have stocks of packaging materials, seed dressing chemicals, fumigants, etc. Effective storekeeping requires:

1. Storerooms that are secure.
2. Storekeepers to keep the store neat, orderly and to control receipt and issue of stocks.
3. Methods to make stock keeping efficient, such as labeled bins, shelves and floor space; alleys for access; and bin-cards for recording stock flow and quantities.
4. Stock management system with goods received notes and requisitions.
5. Regular stock taking and stock

Access and inventory control

The layout of the warehouse must facilitate efficient loading and unloading of seed, fumigation and monitoring of seed in storage. The seed stored in the warehouse should be laid out in a systematic fashion. A system of bays, laid out in ribbons, each labeled and demarcated, will help to keep an orderly record of location and content of seed lots (Figure 5.17). Individual seed lots must be identifiable and stacked separately. Records of incoming and outgoing stock are maintained on stock-control or bin cards (Table 5.11), while the rule of first-in, first-out should be adhered to.

Protection

Seed is a valuable product, and therefore the warehouse must be

- secure from the risk of theft,
- protected from the elements (water-proof),
- ventilated, and
- cool.

The warehouse must also be conducive to effective fumigation of the seed to protect it from storage pests. Vermin are a serious threat to seed, but difficult to control, apart from the use of regulated poisonous baits and accommodation of predators (cats and owls). Cleanliness is absolutely essential in a seed warehouse, as any loose seed lying around will be a source of food for vermin and storage pests.

Table 5.11 Example of a bin card for stock control in a warehouse.

Crop:				Variety:			
Pack size:				Lot Number:			
Bay address:				Seed Class:			
Date	Voucher Number	Quantity Received	Grade	Quantity Dispatched	Balance	Initials	Check

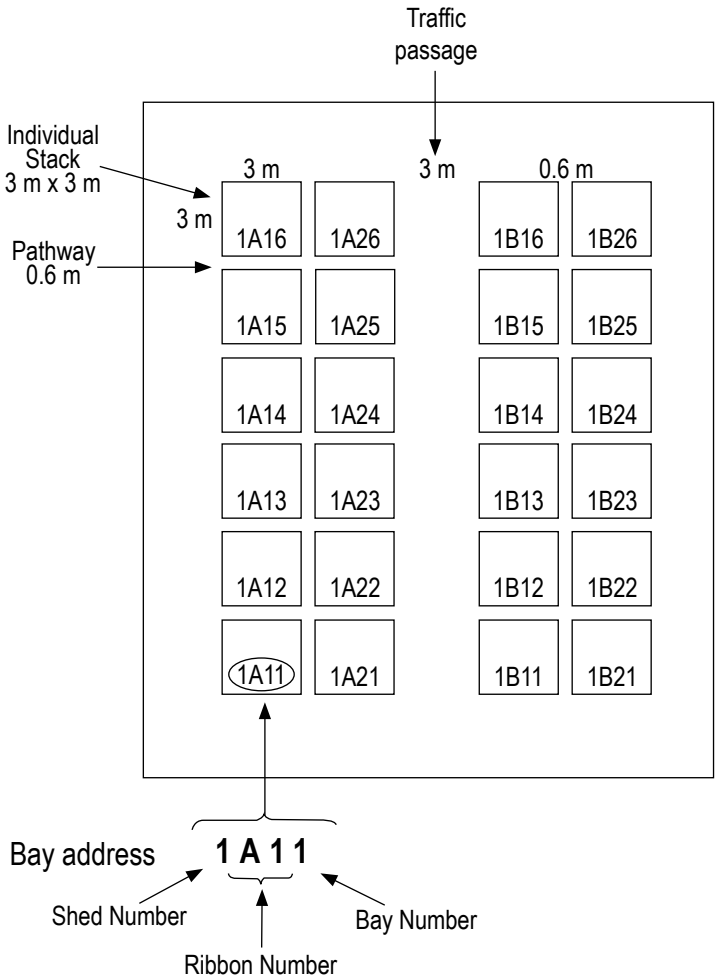


Figure 5.17 Example of a warehouse layout for bag stacking, with ribbons of paired bays separated by adequate passages and traffic lanes to enable easy access, loading and removal of seed.

Contracting farmers

Seed companies are not normally directly involved in the field production of seed, but rather contract farmers to do the seed production under supervision to meet the certification standards and production goals. This relationship between the seed company and the farmer is key to the success of the seed company, and it must be viewed as a symbiotic relationship, in which both parties are dependent upon and gain benefit from the relationship. All successful seed companies have a grower base that is dependable, efficient and durable. The relationship begins with making the right choice of farmer, is established by a clearly defined contract with the farmer, and is continued through servicing the farmer so that the seed is produced to standard, received on time and paid for in a manner that pleases the farmer.

Choosing farmers

Farmers vary in capability and capacity, and making the right choice of farmer to produce seed can make an enormous difference to success. Factors to consider are:

- Location of farm relative to the seed company. The farther the farmer is away from the seed company, the higher will be the cost of supervision of the production and transport of seed to the seed company.
- Farm size. Larger farms provide more opportunity for isolation on the farm itself, without having to negotiate with neighbors concerning production of the same crop outside of the isolation distance. Also, larger farms are more conducive to larger field sizes.
- Field size available. Seed production on very small fields (less than 5 ha) is possible, but may not be an efficient use of resources, because the more fields that need supervision, the higher will be the cost of supervision for the seed company. Also, very small seed fields are more vulnerable to foreign pollen contamination. The optimum size of a hybrid maize seed field has not been determined, but very large fields (greater than 25 ha) will generally be more difficult to manage than medium-sized fields (10 to 20 ha), particularly with respect to roguing and de-tasseling, especially if labor is limiting. Therefore, ideal field sizes for seed production are between 10 and 20 ha, but this is no guarantee of high yield or assured quality—these depend on the management of the field and environmental conditions experienced during production.
- Environment of the farm. The object of the seed company is to produce as much quality seed from as few farms and smallest area as possible. This is most likely to be achieved if production is located in high potential areas. Yields of seed maize are

determined by many factors, and for any given variety, the yields will vary from farm to farm. This might not have been entirely due to adverse environmental conditions, but nevertheless, the environment does place a certain limitation on the potential yield of a seed crop. If the environment of the farm is ideal, then the infrastructure, labor availability and management capacity of the farm will be the main determinants of yield.

- Infrastructure of the farm. Seed production may require specialized equipment, such as planters, sprayers, irrigation, storage sheds and transport. The availability of these on a farm will help ensure that the necessary operations can be carried out to an acceptable level of management. Irrigation facilities are particularly necessary where split-plantings are required in hybrid seed maize production.
- Labor availability. Many operations are labor intensive in seed production, such as planting, rouging, de-tasseling, harvesting and shelling. If labor is constrained and key operations are not carried out properly, seed quality might be compromised.
- Management ability of the farmer. This is difficult to assess, but the general appearance of a farm, the record of previous cropping achievements, and general standing of the farmer in the community are good indicators of management ability. A good farmer need not be highly qualified, rather, he needs to know how to farm in a very practical way, being in close contact with the realities on the farm, with ability to make decisions, and respond practically and innovatively to all the variabilities of farming. Ideally, the farmer should also have experience of seed production, and be able to manage labor well.

Defining the contract

Contracts are legally binding agreements between two partners. The exact nature of a seed grower contract will depend on the circumstances, but will usually contain details of the following specifications, couched in legal terminology:

- Obligations agreed to by the farmer:
  - Agreement to produce a particular crop and variety exclusively for the seed company
  - Quota (volume of product)
  - Quantity of seed to be produced
  - Crop management specifications
  - Certification requirements
  - Allow freedom of inspection of seed fields by company representatives and certifying authorities
  - Seed delivery form, method and schedule

- Obligations of the seed company
  - o Parent seed supply
  - o Production and input support (if any) and repayment terms
  - o Specification of services (e.g., inspections and agronomic advice) to be rendered to the farmer
  - o Seed price to be paid, including any applicable bonuses or penalties
  - o Payment method and schedule

Contracts usually also specify that the germplasm supplied by the seed company and produced by the farmer from then on remains the property of the seed company and may not be used for any other purposes by the farmer. A checklist of factors to consider in drafting seed grower contracts and an example of a grower contract is given (Appendix 2).

Where small-scale farmers are involved in seed production, it may be necessary or preferable to establish the contract with a consortium of growers. This might be with a whole village to ensure that all farmers grow the same variety to avoid admixture or contamination of the seed, or with a cooperative or farmers' group to engender a certain degree of group responsibility and accountability. In these cases, the contract needs to be negotiated with the village head or group leaders, with the full involvement and agreement of the community. The advantage to the seed company, apart from quality assurance, is that greater seed quantities might be produced, while negotiations, transactions and inspections are localized making management a lot simpler than dealing with many individuals each growing a small amount of seed. For the community, the contract offers a level of security and may be used as a means for collective bargaining, securing of loans and community wealth creation.

Seed producer pricing

A number of options exist for determining the seed price paid to growers and the method of payment. The basic starting point is to determine the price paid for seed. Here there are a number of options, viz.,

1. The price is calculated from the average yield of seed and a presumed realistic return per hectare for the farmer (e.g., if the average yield is 4.0 t/ha and a farmer expects a gross income of US$ 2,400 per ha, the seed price is set at US$ 600/t).
2. The price is calculated based on cost plus margin basis. Thus, the seed production costs of the farmer plus a reasonable margin are determined. Then, based on the average expected seed yield, a price is set (e.g., if the production costs amount to US$ 1,200/ha, and a margin of 50% is given, then, with an average seed yield of 4.0 t/ha, the price would be set at US$ 450/t).

3. The price is determined by examining the selling price of seed and working backwards to the farmer, taking into account the seed company margin, overhead expenses and processing costs (Figure 5.18). Within reason, the cost of overheads and processing is similar for a hybrid as for an OPV, but the grower price is set higher for the hybrid because of the extra management required to grow hybrid seed. Thus, the OPV grower price is usually about 70% to 80% of a three-way hybrid seed price.

Whichever method is used to determine the grower price for seed, it is advisable to do this in consultation with the growers, so that the method is transparent and agreed upon by all parties before the growing season begins. This will help reduce conflicts over pricing at the time of seed delivery.

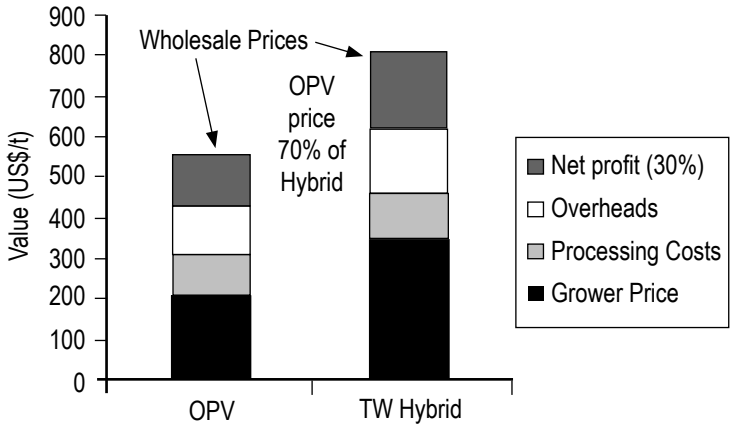


Figure 5.18 A hypothetical comparison of the price build up of maize OPV and three-way (TW) Hybrid seed.

The actual method of paying seed growers may also vary, *viz.,*

- The grower is paid a specified price per ton of seed upon delivery. The payment may be immediate upon delivery or delayed for a certain period until quality checks have been completed.
- The grower is paid a proportion of the seed value upon delivery and the remainder is paid once the seed has passed the quality test or once it is sold. This latter system may be used in a cooperative company setting, or where the market of seed is not assured. The farmer therefore shares in the risk of seed marketing.
- The grower delivers a quota (specified quantity) of seed for which he is paid a set price per ton. Any seed in excess of the quota is delivered but is only paid for at a later date, usually once the seed is sold. This provides a certain security for the seed company in the event that the farmer produces more than what is required, but ensures that the seed is delivered. The farmer then carries the risk of excess production.
- The grower is paid a basic price per ton of raw seed, with a bonus payment for quality (e.g., defects, purity and germination) or for meeting delivery schedules. This system

provides the farmer with certain incentives to produce quality seed according to the seed company's schedule. A negative form of this approach is to apply penalties in the event of poor quality or late delivery of seed.

- The grower is provided with advance credit, either in the form of cash loans or inputs to enable the production of seed. These credits are recovered upon delivery of the seed, and cash payments are only made once the advances have been cleared. In this instance the seed company carries some of the production risk. This may be difficult for some companies, and so a third-party credit supplier (e.g., bank of agribusiness) may be brought in to carry the risk.

Servicing seed producing farmers

The complexity of seed production, especially where hybrids are produced, and the need for quality assurance, requires that the seed company offers a service to the farmer. This service might be in a number of areas:

- The first service that a seed company may offer the grower is that of seed crop inspection, to ensure that the certification standards are met. Failure to meet certification standards is a waste of resources and leads to frustration and losses for both parties. In some countries, seed companies may be accredited to certify seed, but in others this is not possible and the national seed regulators carry out the seed inspections. Regardless of the system, the seed company will benefit from providing a service to farmers in this area.
- The second service is agronomic management advice. Seed production requires specialized management, and farmers are always seeking information and assistance to improve yields and productivity. This service may be part of the seed inspection service, but it may be beneficial to have expert agronomic advisors to deal with particular crop management related issues.
- The third area of service might be the provision of credit and input provision. Many capable farmers may not have the cash resources to finance a seed crop, while the banks are often not willing to lend money directly to farmers for seed production. The seed company might be able to source finance for input supply to contracted growers. The supply of appropriate inputs to seed growers would ensure that the seed production is not limited by the lack of inputs.

Quality assurance

An important component of seed production is quality assurance. This is not a one-off item, tagged on at the end of the production process, when the seed is put into the bags, but it has to be part of every aspect of the seed production process. Quality of seed refers to its fitness for purpose and its conformance to statutory requirements. Although this is defined by the seed regulations, at the end of the day, it is the farmer who evaluates the real value of the seed.

For a seed company to have the assurance or confidence that the seed it sells will satisfy the farmer, it is necessary to implement a quality assurance program. This will specify all the systematic procedures that need to be carried out in the entire seed chain to ensure that the quality of the seed is not a label but the seed itself. Every aspect of the seed company needs to be analyzed, documented and procedures described to ensure that quality is embedded in the system. Every employee should have a conscious understanding of his or her responsibility to conduct their work in a quality manner. Only in this way will a seed company be confident that farmers will receive seed that will satisfy their expectations.

Quality assurance systems revolve around the development and use of a *quality manual,* which describes the quality policy, quality systems and quality practices of the company. The quality policy is developed with the participation of the employees and management of the company, and it specifies the quality goal of the company in producing seed. The quality systems involve the development of *flow charts* and *procedure manuals* for each critical process in the seed chain, which serve as a basis for guiding operators and managers.

The procedure manual specifies the following components related to a particular task:

- The purpose of the task, i.e., the desired outcome of the task.
- The scope of the task, i.e., the beginning and end of the procedure.
- References relevant to the task, such as the documents, data, rules and regulations related to the task.
- Definitions of words, acronyms and abbreviations used in describing the task.
- Responsibilities and authorities relating to who is involved in carrying out the task.
- Action steps that specify what must be done, when and in what sequence. This links directly with a flow chart of the task.
- Records of the task, including outputs, objective evidence that tasks have been completed and documentation required by regulatory authorities.
- Flow chart that provides a visual representation of the task process.

An example of a flow chart for certified seed production is given (Figure 5.19). The flow chart begins from the point where a seed company has no certified seed production and outlines the major steps and decisions to be taken in order to achieve certified seed delivered to the seed processing plant. The detail to which the flow chart goes depends on what intensity of definition is required in the process. For example, flow chart could be developed for each of the major tasks or activities of certified seed production, such as crop inspections—how these are to be done and what documents and source information is required for completion of crop inspection. Similarly, flow charts may be

developed for the processing stages of the seed chain (Figure 5.20), laboratory processes, financial tasks and marketing components. In such a way, the whole business is quality oriented.

Key thoughts

1. Seed production planning is at the core of the production strategy and is designed to establish the required productions of all classes of seed to meet the sales forecasts.
2. Quality seed production begins with ensuring that source seed is of the best genetic quality, and that quality assurance procedures are followed throughout the seed production chain.
3. Field performance of seed crops is optimized through timely operations, high standards of management and efficient use of resources.
4. Maize hybrid seed fields require special attention to planting of male and female components, removal of off-types and variants, removal of tassels of females before anthesis, removal of male plants after fertilization of females and careful seed harvesting to meet certification standards.
5. Seed quality is highest at physiological maturity of the plant and thereafter irreversibly declines at a rate determined by environmental conditions and seed handling. The rate of decline may be minimized by drying seed to less than 13 % moisture, keeping seed in good storage facilities with low air temperature and relative humidity, and keeping the seed free from pest, rodent and disease attack.
6. Processing of seed is carried out to separate desired, good, healthy seed from inferior seed and impurities, to treat seed with chemical protectants and package seed into customer-preferred pack sizes. In some cases, such as with maize hybrids, seed may also be graded into uniform sized seed lots.
7. Seed processing equipment requires constant supervision to achieve efficient outputs, regular maintenance to extend machinery life, and adherence to safety standards to ensure operator protection.
8. Seed warehouse management is based on orderly arrangement of stocks, the use of a system of stock recording and inventory control, together with fumigation and security arrangements to maintain seed viability.
9. Selecting and contracting seed growers who are capable and well-resourced farmers and supporting growers with agronomic information and crop inspections will help ensure the production of sufficient quantities of quality seed.
10. Seed growers are responsive to prices, and so managers must develop a transparent and fair method of compensating farmers for quality seed production.

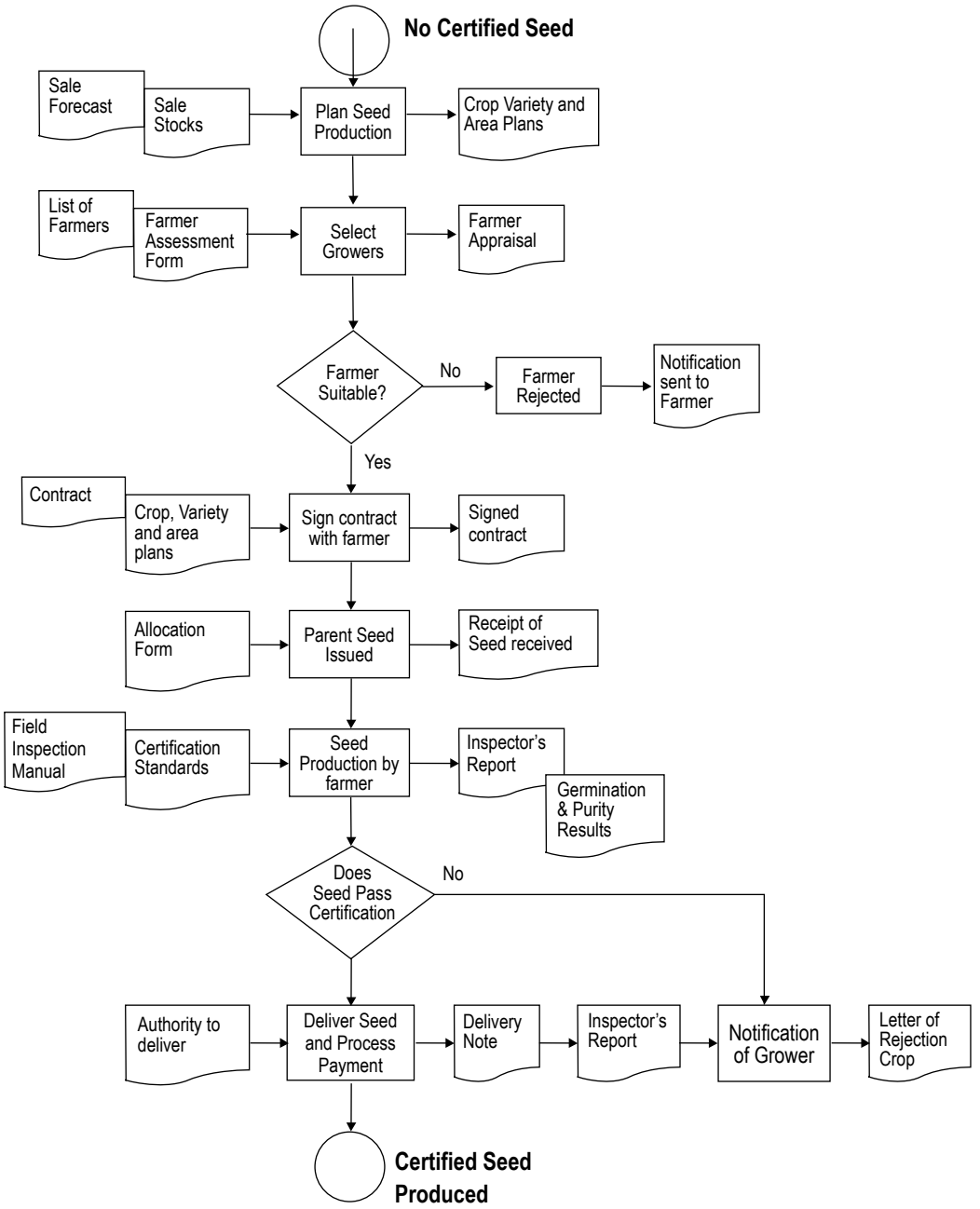


Figure 5.19 Simplified flow chart of certified seed production for quality assurance purposes.

Seed Processing and Certification Procedure Flowchart

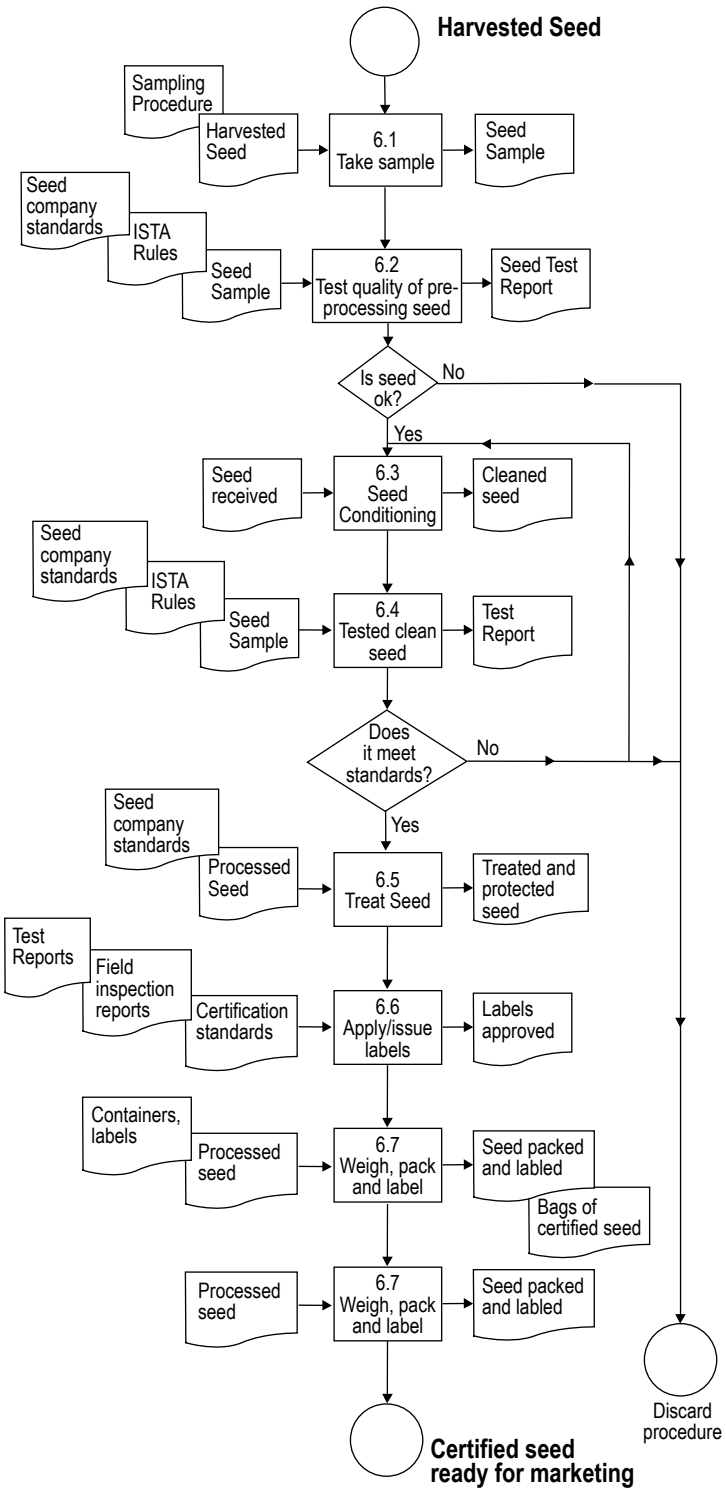


Figure 5.20 Example of a flow chart for seed processing.

Source: *Quality Manual Guidelines for a Seed Company,* Seed Science Centre, Iowa State University (2006)

6

Financial Management of a Seed Business

The financial management strategy of a seed business is like riding a bicycle—the more that the pedals are pushed and rotated, the farther and faster will the bicycle travel. And, as any cyclist can testify, the effort applied to the pedals depends on the load and slope. Heavy loads and steep uphill require extra effort, while downhill and light loads make cycling easier. But still, in most situations, the pedals must be controlled and rotated. Likewise, in a business, the flow of money into, through and out of the business, and the management of that flow, is critical to the success of the business. Many businesses require more cash than they can generate, and few business are self-sufficient in cash flow (Henderson 1973). The financial strategy is therefore one of evaluating the financial requirements and viability of the marketing and production strategies *(the load and the slope),* and putting in place means to monitor *(effort)* and evaluate *(speed and distance)* the financial performance of the business. This requires the development of budgets, the implementation of accounting systems, and the analysis of accounts. Associated with this is the management of risk, investments, equity and tax.

Money flows into, through and out of a business. All businesses need an initial amount of money (capital, in the form of cash or credit) to start the business. This money is used to buy assets, employ staff and generate products or services that are sold. The money earned from sales can then be used to create more products or services, invested into business development, or be diverted to other uses, such as rewarding shareholders. The amount of money (net worth) in a business increases when *more* money flows *into* the business than that which flows *out*. This cycling of money into, through and out of a business is called the ***cash cycle*** or the ***working capital cycle*** (Figure 6.1). The working capital cycle generally covers a period of less than a year and involves purchasing of raw materials on cash or credit, turning them into finished product, selling them for either cash or credit, resulting in debtors and collecting the amounts due from debtors and

putting the money received into the company's bank, and then starting the cycle again. The long-term portion of the cash cycle relates to investment decisions and capital structuring in terms of debt versus equity, as well as other strategic issues which are beyond the scope of this book.

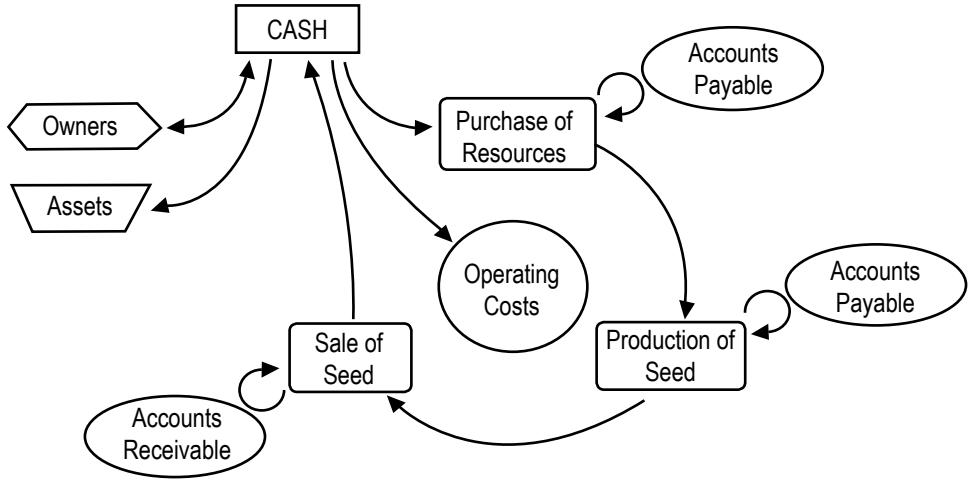


Figure 6.1 Simplified working capital cycle of a seed business.

Business managers need to learn to control or manage this flow of money to their advantage. The success or future of a business very much depends on the management of the working capital cycle. The financial activities of a seed business exist within the macro-economic conditions of a country and are also highly dependent on the agricultural economy and environment. Furthermore, seed businesses are faced with long-term planning horizons and lengthy production cycles. Consequently, there are high degrees of risk and uncertainty, which need to be managed, particularly with respect to forward planning, cyclical cash flow (liquidity) and borrowings (debt:equity).

The following are the most important tools in the financial management process:

- income statement;
- balance sheet; and
- cash flow projections.

These are aided by other internal control tools like the age analysis for stocks, debtors and creditors; budgets, and variance reports, which highlight major deviations against the company's plan; as well as other more operational systems of internal control, such as consumable stock management, petty cash control, and purchasing management. This chapter is concerned primarily with examining the income statement, balance

sheet and cash flow budgeting in a seed company, highlighting the main issues and controls that business managers need to be familiar with.

The income statement—the company's report card

Every company wishes to know how well it is doing relative to its financial goals; the question being, "What is the bottom line?" The income statement (sometimes called the profit and loss account or Operating Statement) is a means of evaluating a company's financial performance, and is at the heart of budgeting and control of the firm's financial status. The Income Statement is essentially a summary of the **turnover** (also known as sales) and all the **expenses** (or costs) incurred in making these sales over a specified period of time.

Most companies prefer to report accounts externally for a twelve month period, and this constitutes the company's financial year. It must however be noted that the income statement can be prepared for any period that the stakeholders require, this could be a day, a week, a month, or six months. Computerized accounting systems, that are maintained current with accurate records, enable frequent, almost real-time, analysis of the company's income statement. Manual accounting systems, however, are usually only capable of providing annual, or at best, six-monthly income statements; but even then, these are usually completed some months after the year-end and therefore serve more as an historical evaluation of the company's performance than as a real-time management tool. Therefore, the establishment and implementation of computerized accounting systems are essential for effective financial management.

The financial year-end that most suits a seed company for evaluating year-on-year performance of the business is ideally one or two months after the main selling period. At such a date, the production and marketing costs related to the sales of the year are usually captured in the same year's accounts. Also, the income and cash levels for the economic year are at their highest. Thus, a company's true profit for the year is determined. Although, inventories are at the lowest level after the selling season, which may not be that good for the balance sheet, the cash reserves of the company should be at or near the peak for the year, which will have a favorable influence on the balance sheet. The setting of the financial year-end, however, may be fixed by the government authorities, usually as the end of the calendar year. In this case, depending on the synchrony of the agricultural season and the calendar year, there may or may not be a mismatch of income and expense flow.

Turnover

The turnover (TO) of a business refers to the gross amount of money earned from selling activities in a particular period. For a seed business this is principally from seed sales, but may also include sales of other related products, such as grain and failed seed. Thus, the turnover relates to the principle products marketed by the firm. If the company sells, for example, its old furniture or cars, the income earned does not constitute part of turnover; rather it is classified as "other income." Similarly, value-added tax received and discounts allowed do not constitute part of turnover.

Turnover is the product of sales' volume (i.e., quantity) and unit price. Thus, the turnover is determined from all the product sales of the company, whether by cash or credit, in a given period. Where a company is selling more than one product (e.g., different crops and varieties) it may be useful to break down the total turnover into the contributions from various categories (Table 6.1).

Table 6.1 Example of the calculation of the turnover of Zambodia Seeds in 2009.

Product	Quantity sold t	Unit Price $/t	Turnover $
Maize seed - Hybrids	1,000	1,300	1,300,000
Maize seed - OPVs	500	950	475,000
Soybean seed	100	700	70,000
Total turnover			1,845,000

Cost of goods sold

The business incurs costs to produce products for sale. This is referred to as the "Cost of Goods Sold" (COGS). The COGS represent the direct costs of producing the seed that was sold to generate the turnover. Thus, COGS is not the total cost of producing all the seed of a company in a given accounting period, but only the cost of the seed actually sold. Seed that was produced but not sold is reported separately on the balance sheet as inventory stocks (an asset). The COGS is therefore calculated as the cost value of the opening stocks of seed plus the cost of seed produced in the period, less the cost value of the closing stocks of seed at the end of the period (Table 6.2).

Table 6.2 The calculation of cost of goods sold (COGS) of seed for Zambodia Seeds in 2009.

	Maize Hybrids	Maize OPVs	Soybeans	Total
		Volumes (t)		
Opening Stock	150	120	0	270
+ Production	1,050	600	135	1,785
– Closing Stock	200	220	35	455
Sales	1,000	500	100	1,600
		Value ($)		
Opening Stock	107,250	74,400	0	181,650
+ Production	750,750	372,000	70,200	1,192,950
– Closing Stock	143,000	136,400	18,200	297,600
Sales	715,000	310,000	52,000	1,077,000

In a seed business, the largest component of COGS is the cost of seed purchased from seed growers, which may constitute as much as 60 % of the COGS. Since most seed companies do not produce seed themselves, but contract this to farmers (seed growers), the seed grower price is a major element in determining COGS. However, COGS will also include other costs related to seed production (e.g. parent seed, inspection services, etc) and to the processing of seed into a saleable form (see Box 6.1).

As with the turnover, where a seed company is producing various crops and varieties, it is helpful to determine the COGS according to these categories. This requires a good accounting system to be able to allocate costs appropriately to each category.

Box 6.1 Typical categories within cost of goods sold in a seed business

Seed Production Costs

- Production staff (Seed Inspectors)
- Vehicles running costs
- Seed transport to warehouse
- Office Costs
- Parent seed cost
- Purchase of raw seed from seed growers

Seed Processing Costs

- Processing staff and labor
- Vehicle running costs
- Office costs
- Machinery repairs and maintenance
- Seed dressing chemicals
- Packaging materials

Gross profit and gross margin

The gross profit (GP) is defined as the turnover (TO) less the cost of goods sold (COGS). This is a straight-forward calculation. Once the gross profit has been determined, the gross margin (GM) percentage may be calculated as,

GM = (TO – COGS) / TO x 100

= GP / TO x 100

Gross margin is therefore the gross profit expressed as a percent of turnover. Thus, the gross margin indicates the percent of turnover left after subtracting COGS. Businesses with high gross margins tend to make high profits as long as the operating costs (overheads) are controlled. Higher gross margins are also an indicator of efficiency in the production process, and exert a direct impact on cash generation. Again, as with turnover and COGS, it is possible to calculate the GP and GM for each relevant category of product in the company (Table 6.3). Gross margin tends to remain fairly stable over time. Significant fluctuations may be a potential sign of fraud, accounting irregularities, or serious problems in pricing and cost management.

Table 6.3 Example of the calculation of the gross profit and the gross margin from the turnover and cost of goods sold (COGS) of Zambodia Seeds in 2009.

Product	Turnover (from Table 1) $	COGS (from Table 2) $	Gross Profit $	Gross Margin
Maize seed - Hybrids	1,300,000	715,000	585,000	45%
Maize seed - OPVs	475,000	310,000	165,000	35%
Soyabean seed	70,000	52,000	18,000	26%
Total	1,845,000	1,077,000	768,000	42%

Operating expenses

The operating expenses (OE) of a seed company are all those expenses that are incurred over and above the direct COGS and which are required to run and maintain the company. The operating expenses are generally unaffected by the volume of seed produced or sold. Thus, they remain "fixed" over time (i.e., they recur on a monthly basis) and regardless of production levels.

The typical operating expenses of a seed business include marketing and research costs and administration (Box 6.2), of which a large proportion is usually employment expenses. The costs of research and development will depend on whether a seed company has a dedicated research department. Thus, research expenditure may range from close to zero to literally millions of dollars, depending on the nature of the business and the need

Box 6.2 Typical operating expenses of a seed business

- Research and development costs
- Marketing costs
- Administration costs
- Accounting department
- Software licenses and IT services
- Human resource department
- Insurance
- Agronomy services
- Warehouse rent
- Electricity and water supply
- Depreciation
- Other miscellaneous costs

for a proprietary breeding program. However, most progressive seed companies will commit a proportion (usually around 5% to 10%) of their turnover to research and development.

Marketing costs are usually considered as operating expenses in a seed business, even though they are tightly linked to sales. The point is, that in most cases, marketing activities will continue regardless of the quantity of seed sold. Marketing costs, especially advertising, may constitute a large proportion of operating expenses, and is therefore an area that needs clear justification for expenditure along with constant monitoring and evaluation. One way of turning a proportion of marketing costs into a variable cost of sales is to pay sales' staff on a commission basis, so that they act as sales' agents of the company rather than employees.

Depreciation is an estimate of the decline in the market value of assets as they age and deteriorate, and reflects the cost of usage of the asset to the business. Thus, depreciation reflects the loss in the value of the machines, equipment or cars owned by the company. It is a non-cash expense, but it is important to incorporate this "cost" into the operating expenses, as these assets will need to be replaced at some future date. Charging depreciation has the effect of setting aside a proportion of income for the replacement of the asset at some future date. There are various methods of calculating depreciation, while different kinds of assets will depreciate at different rates depending on usage, care and obsolescence. Although depreciation may be a tax-deductible expense, the Government Tax Department usually defines the extent and method of determining allowable depreciation.

Operating profit and margin

The operating profit (or income) is a measurement of the money generated from the company's operations, and is a gauge of the general health of the core business. The operating profit (OP) equals the gross profit minus the operating expenses. With these data the operating margin (OM) may also be calculated:

$$OM = (GP - OE) / TO \times 100$$
$$= OP / TO \times 100$$

Again, suffice to say, the operating margin is essentially operating profit expressed as a percentage of turnover. This makes the OM an important measure of management efficiency. A high OM indicates that the company has good control on operating expenses while also achieving good gross margins on products sold. A high OM also

gives the company flexibility in pricing decisions and opportunities for investments in business growth.

Sundry income and expenses
A seed business may earn other income from the sale of old equipment and furnishings, from sundry sales of things like promotional materials, or even other minor trading activities. Sundry expenses may also be incurred that are not directly related to the core business of the company, such as fines. These sundry income and expenses should not form part of the operating profit.

Profit before interest and tax
The operating margin plus sundry income less sundry expenses is called the "profit before interest and tax" (PBIT).

Interest received and paid
Very few seed businesses will operate solely on a cash basis, but will provide credit to customers to facilitate sales, and make borrowings to cover cash-flow deficits and asset purchases. Interest may be earned from credit sales or from investing surplus cash balances, while the company may incur interest expenses on short and long-term borrowings. The interest received and paid fluctuates from year to year. Since interest, whether earned or paid, is not part of a seed company's core business, this had to be reflected as a post-operating profit item on the income statement.

The amount of interest paid is an indication of the extent of borrowings of a company. If a firm is unable to pay the interest on loans, it is in a precarious financial position. From the income statement the "interest coverage ratio" may be calculated to establish the number of times the company could make its interest payments with its earnings before interest and tax.

Interest coverage ratio = PBIT / Interest Expense

The lower the interest coverage ratio, the higher the debt burden faced by the company. As a general rule, interest cover of below 1.5 should alert managers to serious over-borrowing and potential inability to service the debt burden, which might lead to filing for bankruptcy.

Net profit before tax

The net profit before tax shows what the business would have made if it did not have to pay taxes.

Tax

Tax represents the Government's share of the profit. Corporate tax rate varies from country to country but typically ranges from 25% to 45%. The amount payable may be reduced legitimately by good tax planning, e.g., spending on qualifying assets that will benefit the business and spending on allowable expenses.

Net profit

The net profit is the residual profit after accounting for all expenses and obligations and represents what is available for distribution to shareholders and retention in the business. This is the famous "bottom line" that is the ultimate measure of the business' success or failure. The greater the net profit the more efficient is the business and the greater the prospects for growth and investment. Again, the net profit margin is the net profit as a percentage of turnover.

Net profit may be utilized in two basic ways. The first is to recompense shareholders for their investment in the business and this is done by paying them a dividend. The second is to retain earnings for re-investment and to serve as a reserve in the case of unexpected calamities. The proportion allocated to each is the discretion of the shareholders. The directors therefore generally determine the appropriate dividend and earnings retention policy of the company.

Generally, for young businesses with tremendous growth prospects the dividend policy tends to be conservative as more cash is required to invest in increasing capacity and meeting demand. For mature businesses without major expansion projects, dividends of 30% or 40% of net profit may be declared.

Income statement example

Having discussed the components of the income statement, a few further points need to be made, for which an example of Zambodia Seeds will be used (Table 6.4). The evaluation of an income statement for a given period or when comparing consecutive periods is done in terms of the absolute numbers, the relevant margins (gross margin, operating margin and net profit margin) and ratios (interest coverage).

Table 6.4 Income statements of Zambodia Seeds for three consecutive years.

	2009		2008		2007	
	$		$		$	
Turnover	1,845,000		1,515,000		1,396,500	
Cost of Goods Sold	1,077,000		895,000		784,000	
Gross Profit	**768,000**	**42%**	**620,000**	**41%**	**612,500**	**44%**
Operating expenses	435,900		395,000		335,500	
Operating Profit	**332,100**	**18%**	**225,000**	**15%**	**277,000**	**20%**
Sundry Income/Expenses	5,100		2,000		1,450	
Profit before interest & tax	**327,000**		**223,000**		**275,550**	
Interest	21,000		22,350		13,500	
Net profit before tax	**315,000**		**200,650**		**268,850**	
Tax	110,250		70,228		94,098	
Net Profit	**204,750**	**11%**	**130,423**	**9%**	**174,753**	**13%**
Interest coverage ratio	**15**		**9**		**20**	

First, if we examine the most recent income statement , that of 2009, we note that the company produced a gross margin of 42%, an operating profit of 18% and a net profit percent of 11%.

These percentages appear relatively good, as does the interest coverage ratio of 15. A shareholder may be quite satisfied with this performance if the current inflation rate was in the order of 5% to 8%, and alternative investments were earning an interest of 6% to 10 %.

However, if interest rates or potential income from other competing projects were higher, then this net profit percentage may not be satisfactory. Consequently, the managers may be urged to improve the gross and operating margins through improved sales and cost control.

Second, if we examine the performance of the company over the last three years, we note that 2008 was a bad year for the business. Although there was a growth in turnover from 2007 to 2008, all the margins declined and the interest coverage ratio dropped considerably. The most significant contributing factor to this seems to have been a disproportionate increase in COGS and operating expenses compared to turnover. If the data provided included volume and price of seed sold, it may have further indicated the reason why turnover did not increase sufficiently to maintain margins. Alternatively, or concomitantly, there may have been a major increase in costs of production in 2008

compared to 2007. In 2009, there appears to have been an improvement all round, although the margins did not reach the 2007 levels.

Examination of the income statements therefore not only provides management with crucial performance indicators, but also serves as a means to seek out problems in the company and determine strategies of improvement. The roots of all financial woes are either low sales or high costs or both. Trends in income and expenditure point to areas of concern, which when identified need to be delved into to find out what components are not performing as expected. On the positive side, Income Statements provide the kind of information managers need to make further investments and reward employees and shareholders.

Break-even analysis

When examining the income statement it is also helpful to do a break-even analysis, for this serves to indicate the viability and vulnerability of the business. The operating expenses of a company are relatively fixed regardless of the production level and sales' performance, but cost of goods sold and turnover are directly correlated to sales (Figure 6.2). Break-even analysis may be carried out in two ways: the break-even volume or the break-even price. Each of these is based on the profit formula, namely:

Operating Profit = Turnover – Operating Expenses – Cost of Goods Sold
= TO – OE – COGS

First, the break-even volume (BEV) is the point at which turnover equals the sum of operational expenses and COGS. At this point, the company is neither making a profit or a loss. If less seed is sold than the BEV, then the company is operating at a loss, whereas if more seed is sold than the BEV, the company is operating at a profit. In the case where a company is operating at a profit, the margin of actual sales over the break-even volume indicates the buffer the company has in the event of future turnover decline (due to reduced volumes, reduced prices or both).

The formula for calculating BEV is,

BEV = OE / (Price/t – COGS/t)

In our example where there are multiple products sold, the total BEV must be calculated from the turnover per ton (i.e., the average price of seed per ton) and the average COGS per ton of seed sold. Thus,

BEV = OE / (TO/t – COGS/t)

For 2009, the total BEV is,

= 435 900 / (1 845 000 / 1600 – 1 077 000 / 1600)

= 903 t

Thus, while the company sold 1,600 t of seed in 2009, their margin over the BEV was only 697 t. Another way to consider this is that the BEV was about two-thirds of their sales volume, so their margin was 43%.

Second, the break-even price (BEP) may be determined for the given volume of seed sold, as follows:

BEP = (OE + COGS) / Volume Seed Sold

Thus, for our example for the year 2009,

BEP = (435 900 + 1 077 000) / 1 600

= $945.56/t

The actual average selling price was $1,153.13/t (i.e., TO/Volume), which indicates that the company did not have much room to maneuver on the average price.

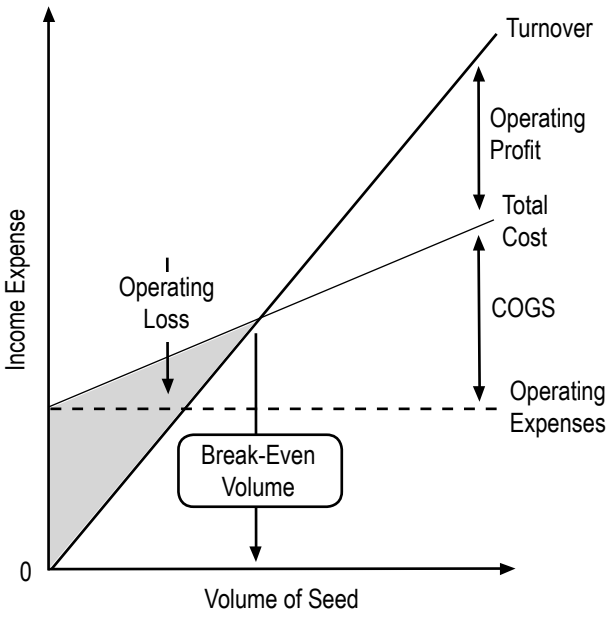


Figure 6.2 Relationship of operating expenses, cost of goods sold (COGS), total cost and turnover on operating profit or loss and determination of the break-even volume.

When comparing the two break-even analyses, it is apparent that the company was more vulnerable to price than volume reductions (Table 6.5). A 10% decrease in price or volume would have the same effect on the turnover, but each would have different

impacts on the COGS and gross profit. A 10% decrease in price reduces TO by 10%, but has no effect on COGS (assuming the same volume of seed sold) and therefore results in a significant decrease in gross profit. On the other hand, a 10% decrease in the volume of seed sold at the same price, decreases TO and COGS, and so does not reduce profits as much as in the case of a 10% decrease in average price. However, when volume sales decrease, carry-over stocks will increase, for a given level of production. Although these stocks will appear as an asset on the balance sheet, the longer-term impact on the company will depend on whether the stocks are eventually sold or not. Companies' break-even points tend to vary and different companies tend to have different break-even points depending on their cost structures and sensitivity to volumes and prices.

Table 6.5 The effect of a 10% reduction in the total volume or average price on the turnover, COGS and profits and margins of Zambodia Seeds in 2009.

	Original		Volume reduction		Price reduction	
Volume	1,600 t		1,440 t		1,600 t	
Price	$1,153/t		$1,153/t		$1,038/t	
Turnover	1,845,000		1,660,500		1,660,500	
COGS	1,077,000		969,300		1,077,000	
Gross Profit	**768,000**	**42%**	**691,200**	**42%**	**583,500**	**35%**
Operating expenses	435,900		435,900		435,900	
Operating Profit	**332,100**	**18%**	**255,300**	**15%**	**147,600**	**9%**
Decrease in OP			77%		44%	

Each of these two break-even analyses may be done for each product line, but the operating expenses then need to be apportioned on a weighted basis amongst the products, based on a relative volume or COGS. Furthermore, not every company is able to determine the exact COGS per product line, and so COGS may also have to be apportioned in some manner amongst products. The break-even analysis of each product, together with the gross margin and contribution of each product to the total gross profit are good indicators of which products are the most profitable and stable, which need improvements in financial efficiency or those which should be discontinued. However, in some cases a product with a low contribution or gross margin may be a complementary product to a "cash cow" and removal of it from the product portfolio may negatively impact on the "cash cow". An example of this may be soyabeans or groundnuts, which typically have poor margins but provide farmers an excellent rotation crop for maize, which usually has high margins.

The balance sheet — the company's health check

The balance sheet is similar to a doctor's check up, for it is a statement of the company's financial condition on a particular date. It summarizes everything that the company owns (assets) and every amount that is owed to third parties (liabilities). The preferable result is for the assets to be significantly higher than the liabilities.

The balance sheet, in broad terms, is composed of:

- capital and retained earnings,
- current assets,
- fixed assets ,
- current liabilities, and
- long-term liabilities.

The total of the capital and retained earnings, and the current and long term liabilities, should be equal to or "balance" with the total of current and fixed assets, hence the term "balance sheet". The balance sheet gives an indication of whether the company is in a good or poor financial state, or simply stated, whether the company is solvent or not. It also indicates whether the company is in a liquid position or not.

Liquidity refers to the ability of a company to quickly generate cash to meet its financial commitments. Assets are repositories of liquidity, and are tangible and intangible items that, in general, earn income for the firm or can be converted to cash. The degree of liquidity of an asset is measured by the time it would take for the asset to be converted to cash. Those assets that may be quickly converted to cash are called current assets, while those assets which would take a long time to be converted to cash are called fixed or long-term assets.

Lack of liquidity should not be confused with insolvency. A company is insolvent when the business' total assets (i.e., both current and fixed assets) are lower than its total liabilities (i.e., both current and long term liabilities). In other words, if such a business sells all its assets it will not be able to pay off its debt. On the other hand, liquidity refers only to current assets versus current liabilities. If current assets do not exceed current liabilities, but total assets exceed total liabilities, then the company is illiquid but solvent. Although it will have problems meeting day-to-day commitments, in the long-term, given enough time to sell all its fixed assets, the company would still be able to pay off all its liabilities. So the clear distinction is that ***insolvency*** refers to all assets

compared to all liabilities, whereas ***liquidity*** refers to only current assets compared to current liabilities.

Capital and retained earnings

Capital and retained earnings, also normally referred to as "Shareholders Funds'" or "Capital Employed", represent the money that the shareholders have put into the business and the net profit they have left in the business after declaring dividends and any other appropriations. Also falling under capital are any reserves arising out of the re-evaluation of fixed assets.

Current assets

Current assets are commonly made up of:

- receivables or debtors,
- stocks or inventories,
- cash and cash equivalents (i.e., bank deposits and savings), and
- short-term investments.

Managing receivables

Receivables refer to the debtors of the business, usually identified as the money owed to the company by its customers who purchased (seed, in the case of a seed business) on credit. Debtors are listed on the balance sheet as current assets as it is expected that they will be paid within a twelve month period. If debtors are not managed properly they can lead to cash flow problems, or even to bad debts, which will impact negatively on profits and liquidity. Thus, the faster a company collects its receivables, the better. The sooner that customers pay, the sooner can a company put the money in the bank, pay off its own debts or start making new products.

A measure of the time taken to collect customer debts is the debtor days, determined by the following formula:

Debtor Days = Average Debtors / Credit Sales x 365,

where Average Debtors = (Opening Trade Debtors + Closing Trade Debtors) / 2

The debtors days should be compared against the company's credit policy to see if the company is managing its debtors well. If, for example, the company's credit policy is 30 days then:

- if the average collection period is below 30 days, this means good management and debt collection; or
- if the average is over 30 days, then it means poor management of debt collection.

Pre-paid expenses also constitute part of debtors. Businesses quite often pay for goods or services before they actually receive them. Examples are:

- Rent paid for a whole year in advance.
- Insurance paid for a period in advance.
- Advance payments to seed growers.

Although some of these may not be easily converted to cash, they still represent money owed to the company and are therefore assets.

Inventory (stock) management

Inventories consists of merchandise a business owns for sale, but which has not been sold. Inventory of seed companies is principally seed, but may also consist of packaging materials, seed dressing chemicals and other consumables. Seed companies will have significant inventories at certain times of the year, particularly just prior to the selling season. These inventories may be made up of raw seed and seed processed and ready for sale. After the selling season is over, seed companies may be left with unsold stock. Since seed is a perishable product, a decision has to be made whether the seed will still meet the minimum germination standards by the time the next selling season begins. If not, the seed needs to be disposed of.

The actual value of inventories is not known until the product is sold, and therefore the company has to estimate values for the balance sheet. For raw seed, this would normally be determined as the price of grain or the cost of the seed, while processed seed may be valued at the net selling price. Seed that has failed quality assurance would be valued at the net realizable price, usually equivalent to the ruling grain price. While there are various methods of valuing inventories, on the balance sheet they are generally stated at the lower of cost or net realizable value.

Investors usually want very little money tied up in inventories, because inventories need to be sold to realize cash, and sales may not be easy to achieve. Furthermore, high stock levels which are slow-moving may lead to losses due to obsolescence or loss of quality. Consequently, for seed, the principle of first-in, first-out is critical to maintain viable stocks. Seed that is processed and treated but which loses germination viability represents a significant loss of value.

Fixed assets

These are the assets that the business owns but cannot be used to fund day to day operations. Fixed assets consist of items that usually have a life-span of more than one year, such as:

vehicles,

- plant and equipment,
- land and buildings, and
- furniture and fittings.

Fixed assets provide benefits to the company for a period that exceeds the current accounting period and are used in the process of generating saleable goods or in the management of these activities. Fixed assets, except land, deteriorate with time, as a function of use, and are thus depreciated. The values at which fixed assets are listed in a balance sheet are generally conservative, normally calculated as the acquisition cost less depreciation, or the current market value. In inflationary economies, fixed assets may be valued at the replacement cost.

Another form of fixed assets is long-term investments that the company intends to hold for more than one year. These may include:

- Shares and bonds of other companies.
- Shares of subsidiaries and associate companies.
- Cash that has been set aside for specific future projects.

Intangible assets consists of things that the company owns but which cannot be touched, such as plant breeders' rights, patents, trademarks, brand names, franchises, good will, and intellectual property. These assets, while playing a significant role in a company's activities and success, are extremely difficult to value, and are not normally reflected on the balance sheet.

Liabilities

A liability is an obligation to pay a debt provided by a lender or other creditors. It represents an obligation to pay a third party. Thus, liabilities are the opposite of assets, for they represent an outflow of cash and generally generate expenses to the company.

Like assets, they may be classified according to the time when they must be paid. Current or short-term liabilities are those obligations that must be paid within the next financial period (i.e., usually in the forthcoming year), while long-term liabilities are obligations that will be paid over an extended period, such as long-term loans, debentures and preference shares.

Examples of current liabilities are:

- Short-term loans.
- Accounts payable.
- Customer deposits.
- Payments due to growers for seed received.
- Amounts owed for seed received "at risk" (in the case of seed production, this refers to an arrangement whereby a seed quota is agreed upon and paid for upon delivery, and any seed delivered that exceeds the quota is delivered but not paid for until sold—the producer therefore produces the seed "at risk" of not being paid).

Examples of long-term liabilities include:

- Debentures.
- Mortgage bonds.
- Any loans whose repayment is to be done over more than a year.

Working capital

Working capital is the sum of money invested in current assets, while net working capital is current assets less current liabilities. Net working capital should always be positive; otherwise the company will be in serious trouble, as it will not be able meet its day-to-day cash requirements.

Balance sheet analysis

The analysis of the balance sheet is concerned with the interpretation of:

- the absolute values,
- the relationships of assets to liabilities, and
- the "stories" behind the numbers.

Since the balance sheet is like a "snap shot" of the company's financial status on a particular date, it is helpful to evaluate it against previous balance sheets, to establish trends, and also to compare it against those of similar sized organizations. There are many ways to analyze balance sheets, most of which involve the calculation of ratios within the balance sheet, and between balance sheet and income statement data (Table 6.6). The use of ratios overcomes, to some extent, the differences in absolute values that exist between different balance sheets. However, when comparing or evaluating ratios, it must be borne in mind that the numerator, denominator or both determine the ratio and provide the "story behind the number" (Figure 6.3). Thus, for example, if a ratio decreases, it may be because the numerator has decreased, the denominator has increased,

or both the numerator and denominator have decreased, but disproportionately. Furthermore, a ratio on its own is somewhat meaningless; to be useful to a manager, the ratio must be compared with industry standards, similar companies and with historical own-company performance.

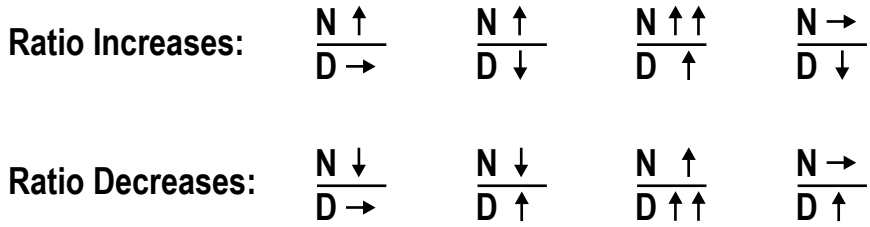


Figure 6.3 The four possibilities in the change in the numerator (N) and/or denominator (D).
Note: These changes will bring about an increase or decrease of a ratio. Upward arrows indicate an increase, downward arrows a decrease, and horizontal arrows no change in the value of the numerator or denominator.

To illustrate the analysis of a balance sheet, an example of Zambodia Seeds is provided (Table 6.7). For the year ending 2009, Zambodia Seeds had a net worth of $930,000, which has increased consistently over the three-year period under review. The net working capital amounted to $301,000, with a current ratio of 2.30, compared to 2.24 and 2.09 for the two preceding years, respectively. In financial terms, a current ratio of greater than 2 is usually considered healthy as it means the company could liquidate its near-cash assets and pay its liabilities two times over within a short space of time. This trend indicates a strengthening in the financial position of Zambodia Seeds. A low net working capital may hinder business development and expose the company to difficulties in relation to creditors and seasonal uncertainties.

The company has been investing in fixed assets and has also put some funds into long-term investments, the latter perhaps to provide some security in the event of a bad season. However, it may have been more prudent to channel cash towards more liquid assets, especially if growth in production is desired.

Inventories show an increase from year to year, possibly because sales' efforts have not achieved targets. Likewise, the accounts receivable have been increasing from year to year and may indicate that debt collection is not as good as it should be. These two indicators may highlight the need for improving the performance of the marketing department and the credit control department. However, a word of caution: this increase could also just be in line with the general growth in the business, and might not be indicative of any pressing problems. The figures cannot simply be looked at in isolation, but must

be viewed in relation to what has happened to the rest of the business, which cannot be done in a theoretical case study like this.

In terms of the company's liabilities, bank borrowings have increased from year to year, but this increase has been in line with the general increase in business. The acid test ratio of one shows that the company is able to pay its current liabilities without having to liquidate stocks, which generally take a longer time to turn into cash compared to all the other current assets.

All-in-all, therefore, the balance sheet and income statement indicates that Zambodia Seeds is in a generally satisfactory financial position, showing strong liquidity and ability to meet short term requirements. Profit margins were reasonable (Table 6.4), but the company needs to control expenditure and exert more effort on sales.

This brief analysis shows that it is possible to evaluate a business's financial "health" by looking at its income statement and balance sheet, and like a good doctor, identify areas that need attention in order for the business not to collapse, but rather grow in profit, liquidity and long-term viability.

Table 6.6 List of commonly used ratios for evaluating the financial health of a business.

Liquidity Ratios	Formula	Meaning
Current Ratio	Current Assets/Current Liabilities	Shows how well a company is able to pay off its short term debts using its most liquid assets. A ratio of 2 is acceptable.
Acid Test Ratio or Quick Ratio	(Current Assets – Stock)/Current Liabilities	More vigorous test of company's liquidity, stocks are the least liquid of current assets. Stocks are not easily converted to cash to meet urgent commitments. A ratio of 1 is acceptable.
Net Working Capital	Current Assets – Current Liabilities and paid off short-term liabilities	What would remain if company liquidated all its short term assets
Activity Ratios		
Fixed Asset Turnover	Turnover/Total Fixed Assets	Indicates how well the company is using its fixed assets to generate sales. The higher the ratio the better, as it shows that the business has less money tied up in fixed assets for each dollar of sales
Inventory Turnover	COGS/Average Inventory	The number of times a company is able to acquire inventories and convert them into sales. A low ratio may indicate slow-down in trading or build-up in inventory levels.
Debtors days	Average Debtors/Credit Sales x 365	Higher period means higher cost of extending credit to customers
Stock Days	Average Closing Stock/COGS x 365	Numbers of days that stocks are held before being converted to cash
Creditors Days	Average Creditors/COGS x 365	Number of days it is taking to pay creditors
Cash cycle	Debtor Days plus Stock Days less Creditor Days	This shows how long it takes for cash disbursed for purchases to come back into the company. The shorter the cycle the better.
Debt or Solvency Ratios		
Debt Ratio (Debt Asset Ratio)	(Total Debt/Total Assets) x 100	What percent of assets have been financed by debt.
Debt/Equity Ratio	Total Debt/Total Equity x 100	Measures the direct proportion of debt to equity capital. A ratio over 100 % indicates a highly geared company and any prudent lender will not extend finance to such a company. A 20 to 30 % debt to equity ratio is generally acceptable.
Interest Cover	Operating Profit/Interest Expense	Measures the ability of the business to pay its lenders. Low interest cover is associated with high gearing. A cover of at least three times is generally acceptable.
Fixed Payment coverage ratio	Turnover/Operating Expenses	Indicates the ability of the business to pay its fixed expenses, when business activity falls.
Net Asset Value	Total Assets less Total liabilities	Indicates the net worth of the company. For this to be meaningful, assets must be valued at their net market value.

Table 6.7 Balance sheet of Zambodia Seeds as at 30 June of three consecutive years (x 1000 $).

	2009	2008	2007
ASSETS			
Fixed Assets (Land, Buildings, etc.)	567	460	385
Long term investments	62	56	45
	629	516	430
Current Assets			
Inventories	298	182	160
Account receivables	156	132	112
Cash resources	79	63	45
Total current assets	533	377	317
TOTAL ASSETS	1,162	893	747
EQUITIES AND LIABILITIES			
CAPITAL AND RESERVES	930	725	595
Shareholders funds	930	725	595
Current Liabilities			
Bank borrowings	95	75	40
Account payables	17	15	11
Taxation	110	70	94
Short-term liabilities	10	8	7
Total Current Liabilities	232	168	152
TOTAL EQUITY AND LIABILITIES	1,162	893	747
Shareholder funds reconciliation			
Opening balance	725	595	420
Add profit for the year	205	130	175
Balance	930	725	595
LIQUIDITY RATIOS			
Current Ratio	2.30	2.24	2.09
Acid Test Ratio	1.0	1.2	1.0
Net Working Capital	301	209	165

Cash flow — the company's fuel meter

The cash flow refers to the movement of cash into and out of the company over time. For a seed business selling field crop seeds, this is a particularly important aspect of management, because the selling season comprises a short period of the year, whilst expenses occur throughout the year and peak a few months prior to the selling season. Hence, there is a concentrated period of cash inflow, and an extended period of cash outflow (Figure 6.4). A seed company typically sells its product for only three months of the year, while it has to incur operating expenses throughout the whole year. As a result, it ends up enduring a number of months where there is no cash coming into the business, but a lot of money is going out due to the need to pay salaries, seed production costs and other day-to-day requirements. Understanding the cycle of the business' cash inflows and outflows helps manage the cash balance.

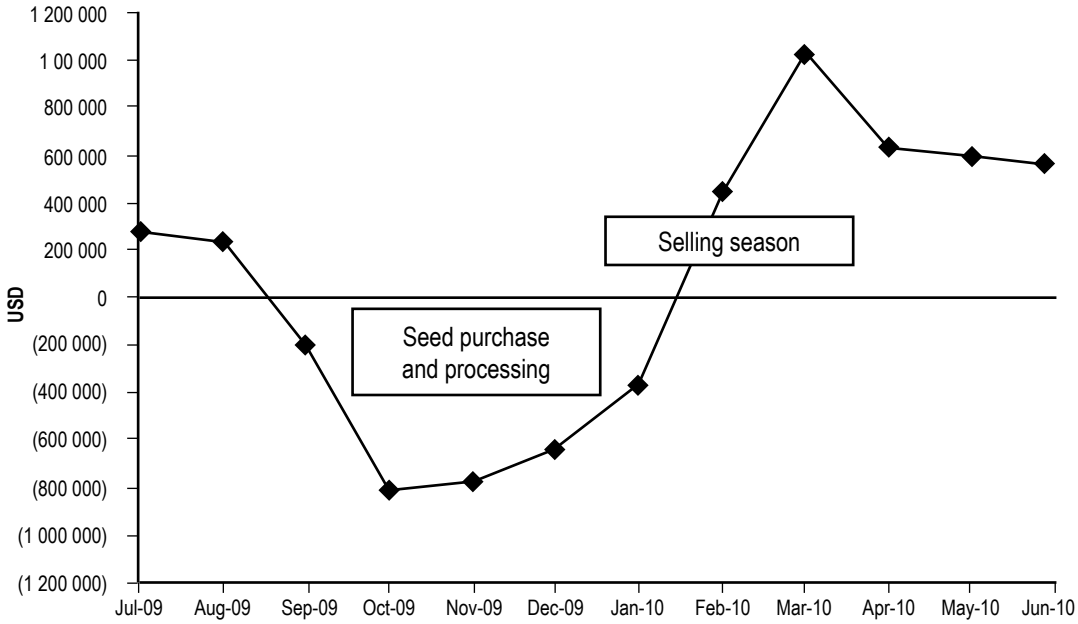


Figure 6.4 Graphical depiction of a typical annual cash flow of a seed business.

Note: Refer to Zambodia Seeds, from Table 6.8, where the company relies purely on a bank overdraft to accommodate the negative cash flow from September 2009 to January 2010.

Cash inflows need to exceed outflows, otherwise there will be a cash shortage resulting in the inability to pay commitments as they fall due. If inflows exceed outflows it means there will be surplus funds, which may be used to invest or grow the business.

Ways to close the cash flow gap include,

- Aiming for significant and year-round cash sales.
- Invoicing credit customers promptly.
- Tightly monitoring credit sales and adjusting credit limits accordingly.
- Offering customers early settlement discounts.
- Establishing a deposit policy for all work in progress.
- Tracking accounts receivable and actively pursuing payments.
- Purchasing consumables on credit for payment when the cash flow is positive.
- Encouraging "at risk" production with growers, which will only be paid for when the seed is sold.

As shown (Table 6.8 and Figure 6.4), seed businesses will usually have a significant negative cash position during the seed purchasing and processing period. To overcome this, short-term bridging finance is required, either in the form of a bank over-draft, loans or additional shareholder investment. The preparation of a robust cash flow projection, together with a forecasted income statement and balance sheet will assist in convincing lending institutions or shareholders to provide the required funds. A key aspect of projections is to be conservative and realistic.

Cash cycle

The cash cycle is the length of time that elapses from the point when cash is disbursed to buy raw materials for the production process to the point when cash is collected from sales of the seed produced. In terms of a seed business this means the time between the payment of money to growers for their seed and the banking of the proceeds from the sale of the seed by the company.

The formula for calculating the cash cycle is,

CC = AAI + ACP – APP,

where,

AAI = average age of inventory,

ACP = average (debtors) collection period, and

APP = creditors average payment period.

The key factors in reducing the cash cycle are:

- Credit policy - insisting on shorter terms of credit.
- Collection period - ensuring all debts are collected as quickly as possible.
- Inventory holding period - ensuring stocks are held for the minimum possible time.

The cash turnover rate (CTR) is the number of times in a year that the cash cycle is repeated. The formula is:
CTR = 360 / CC, where CC stands for cash cycle as calculated in the preceding paragraph.
Shortening the cash cycle increases the cash turnover rate and increases cash inflow.

The minimum operating cash balance (MOCB) is the cash balance required to enable the company to pay short-term expenses like wages and interest to avoid going into liquidation. Knowing and maintaining the MOCB ensures that the company can meets its day-to-day needs, meet emergencies and take advantage of opportunities.

The calculation of MOCB is as follows:
MOCB = TAO / CTR, where
TAO = total annual outlays of cash (i.e., all the cash payments for the year), and
CTR = cash turnover rate

Leasing of assets
Leasing is a form of cash flow management because it overcomes the problem of large cash disbursements required to procure the use of an asset. A lease is a contract between an owner of an asset (the lessor) and the user of the asset (the lessee), in which the lessee pays an agreed amount at certain intervals for the use of the asset. Types of leases include:

- *Financing lease.* These are usually long-term contracts in which the lessee obtains sole use of machinery or equipment upon regular payments. Usually, the lessee is responsible for running and maintenance costs for the duration of the contract. At the end of the contract the items are returned to the owner or sold to the lessee at nominal value.
- *Operating lease.* These are short-term contracts, in which the lessee obtains use of equipment and machinery for particular operations or tasks, such as excavators for trenching, trucks for deliveries, and equipment for building. These leases may be charged per hour, week or month, and usually the risks and maintenance remains with the owner.
- *Lease-purchase agreements.* In some lease agreements, the lessee may have the option to purchase the equipment at the end of the lease period at a pre-determined price.

The advantages of leasing are as follows:

- It is a source of non-loan financing.
- The installments are usually tax-deductible in most tax jurisdictions.

- It usually does not have restrictive clauses (compared to out-right borrowings).
- Obsolescence may be avoided.

The disadvantages of leasing include the following:

- Regular payments required that may add up to a greater cost than purchase and self-maintenance.
- There may be no salvage value.
- Any improvements made to land or buildings remain with the lessor at the end of the lease.

Seed businesses will normally only have the option to use lease agreements on land, buildings and vehicles. Seed cleaning and processing equipment is not commonly available for leasing, although it may be possible to find other seed companies that will offer "toll processing". Where a company wishes to lease buildings for erecting processing equipment, long-term leases of five or more years would give greater security than short-term leases. However, short-term warehouse leasing may be useful for the period in the year when raw seed is received and processed into saleable product.

From a purely financial perspective, the decision of whether to lease or purchase an asset with cash or borrowings may be evaluated by using discounted cash techniques to arrive at the Net Present Value (NPV) of the future lease payments and comparing this to the amount required for outright purchase. If the NPV of the future lease payments is higher than the amount required for outright purchase then it is preferable to buy the asset rather than lease it. However, consideration also has to be made of the advantages and disadvantages of either leasing or owning the asset in terms of its effects on the cash flow, utility, profitability and balance sheet of the company.

Budgeting

Strategic financial management requires the development of budgets, or financial plans, for the business. Budgets clearly articulate what the organization intends to achieve in financial terms and how the organization intends to deploy the limited resources at its disposal to achieve these objectives. Detailed budgets are usually prepared for the coming year, but these may be extended into the future for three or more years. The detailed budget for the forthcoming year has three main purposes: the first is to set a performance target for the period in question; the second is to establish a control mechanism to guide the daily and monthly operational activities of the company; and the third is to provide justification for accessing loans. The extension of budgets into future years enables managers to formulate and understand the longer-term prospects and strategies of the business.

In brief, the process of developing budgets begins with establishing the marketing and production strategies of the company (Figure 6.5). These plans have much to do with seed volumes which have to be translated into financial terms to create the sales and production budgets. Along with the sales and production budgets, the operational budget needs to be defined. This requires estimating the operational costs of the company, that usually occur on a regular monthly basis, such as salaries, vehicle operating costs, research and development, marketing costs, and so on (Box 6.2). These three budgets — sales, production and operational — budgets then feed into the cash flow budget and income budget.

Box 6.3 Rules for cash flow management

1. Never run out of cash. Running out of cash is the definition of failure in business. Make the commitment it takes to ensure the business always has sufficient cash. No cash means no business, so manage cash flow with the care and attention it requires.
2. Know the current cash balance. Managers should have current knowledge of the cash balance. Even the most experienced managers will fail if they are making decisions based on out-of-date, inaccurate or incomplete cash balances.
3. Do today's work today. The key to having an accurate cash balance is having up-to-date records. Do the work or get someone else to do it for you so that you have a grip on the current cash flow status of the business.
4. Don't manage from the bank balance. Don't confuse the cash balance with the bank balance! You reconcile your bank balance, you don't manage from it! Know how much cash you really have.
5. Know your projected cash flow. What do you expect your cash balance to be in the coming months? Cash flow problems don't just happen. Most businesses fail because the owners or managers do not see a cash flow problem in time to do something about it. The key is always to be able to answer the question "What do I expect my cash balance to be six months from now?" Therefore, cash flow projections are key to making wise and profitable business decisions.

Source: Adapted from Campbell (2004).

Cash flow budgeting involves forecasting the sales and production budgets over future months (Table 6.8). Sales targets are set month by month to determine monthly sales. Seed production to meet the sales' targets is calculated, together with estimates of seed grower prices, delivery schedules and the processing timetable. Together with the processing costs, the monthly production and processing costs may be calculated. Monthly operational costs are also itemized and estimated, which will be fairly constant through the year. The net monthly inflow is calculated from the turnover less production and processing costs, less the operating expenses, while also accounting for any other costs (such as interest payable or purchase of capital items) and income (such as loans received and sundry income).

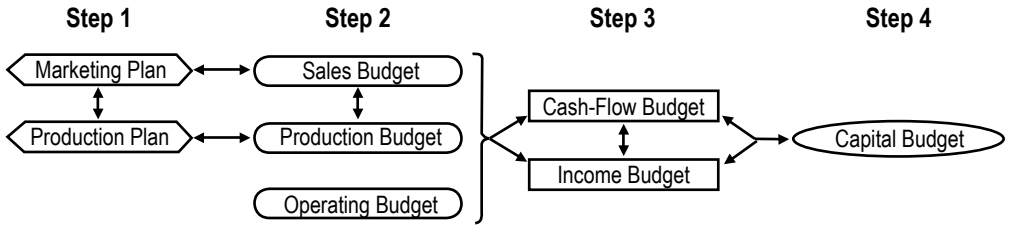


Figure 6.5 The budgeting process in a seed company.

Note: Arrows indicate the iterative nature of budget preparation.

The income budget accumulates the totals from the sales, production and operational budgets in an income statement to establish the predicted profitability of the company at the close of the financial year. Having established the cash flow and income budgets it is then possible to consider the capital budget, since the decision to purchase or lease capital (asset) items may only be made once the profitability and cash position of the company is known. Once the cash flow, income and capital budgets have been formulated, the company is then in a position to determine its borrowing requirements.

Developing budgets is an iterative process, as managers seek to achieve an acceptable cash flow, sufficient profit expectations, and acquire necessary assets for business growth. Ideally, the entire company should be involved in the budget preparation so that it is "owned" by all employees. To make the process effective, managers need to specify the budget parameters and give guidelines at the beginning of the exercise, so as to avoid misunderstandings as the process develops and is approved. Typical parameters include anticipated wage increases, inflation rates, pricing expectations, mileage allowances, etc. It is also wise to be conservative in preparing a budget by not inserting over-ambitious sales estimates and by incorporating margins of error on expenditures.

Budgets are estimates and therefore deviations are likely to occur. The budgets must be considered as guidelines and they should be flexible in the event of new information or changes in macro-economic conditions. Nevertheless, budgets are not meant to be manipulated month by month to accommodate mismanagement of the business. Once a budget has been set, any changes should only be made if they are truly justifiable.

Budgets are instrumental in informing company employees of management's expectations concerning sales and expenditure and are necessary for tracking monthly progress towards achieving the company's vision according to the defined strategies. Expenditure within departments must be kept in line with budgets in order to achieve the expected cash flow. Monthly sales, production, cash flow and profitability may then be compared with the budget to highlight successes, problems and failures. Thus, the budgets of a company are an important management tool to track and evaluate progress and profitability.

Table 6.8 Example of a cash flow budget for Zambodia Seeds for the period July 2009 to June 2010.

	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10
OPENING BALANCE	320,000	279,901	231,291	(210,301)	(818,067)	(776,172)	(640,524)	(379,309)	435,725	1,039,230	638,231	597,130
Sales												
Maize Hybrid	0	0	0	0	81,480	162,960	256,662	684,432	513,324	0	0	0
Maize OPV	0	0	0	0	27,936	55,872	87,998	234,662	175,997	0	0	0
Soyabeans	0	0	0	0	0	0	15,278	76,388	61,110	0	0	0
TURNOVER	0	0	0	0	109,416	218,832	359,938	995,482	750,431	0	0	0
Interest received	0	0	0	0	0	0	0	0	0	0	0	0
TURNOVER	**0**	**0**	**0**	**0**	**109,416**	**218,832**	**359,938**	**995,482**	**750,431**	**0**	**0**	**0**
Production and Processing Costs												
Raw seed & delivery												
Maize Hybrid	0	0	300,303	300,303	0	0	0	0	0	0	0	0
Maize OPV	0	8,412	100,945	100,945	0	0	0	0	0	0	0	0
Soyabeans	0	0	0	80,101	0	0	0	0	0	0	0	0
Processing Cost												
Maize Hybrid	0	0	0	0	9,661	19,322	28,984	77,290	57,967	0	0	0
Maize OPV	0	0	0	0	5,500	11,000	16,500	43,999	32,999	0	0	0
Soybeans	0	0	0	0	0	0	912	4,559	3,647	0	0	0
Total Production Costs	**0**	**8,412**	**401,248**	**481,349**	**15,161**	**30,322**	**46,395**	**125,848**	**94,614**	**0**	**0**	**0**
Operating Expenses												
Parent Seed	0	0	0	83,160	0	0	0	0	4,800	0	0	0
Distribution	0	1	44	54	873	1,746	2,813	7,954	6,014	0	0	0
Marketing Costs	4,365	4,394	4,423	4,453	4,483	4,512	4,543	4,573	4,603	4,634	4,665	4,696
Salaries	15,684	15,684	15,684	15,684	15,684	15,684	15,684	15,684	15,684	15,684	15,684	15,684
Rent	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7 ,500	7,500	7,500	7,500
Security	4,190	4,218	4,247	4,275	4,303	4,332	4,361	4,390	4, 419	4,449	4,478	4,508
Office Costs	1,571	1,582	1,592	1,603	1,614	1,624	1,635	1,646	1,657	1,668	1,679	1,691
Vehicle Costs	3,143	3,164	3,185	3,206	3,227	3,249	3,271	3,292	3,314	3,337	3,359	3,381
Sundry Costs	3,645	3,654	3,668	3,678	3,768	3,865	3,981	4,504	4,319	3,727	3,737	3,746
Interest charges	0	0	0	2,804	10,908	10,349	8,540	5,057	0	0	0	0
Total Operating Costs	**40,099**	**40,198**	**40,343**	**126,417**	**52,360**	**52,862**	**52,327**	**54,601**	**52,311**	**40,999**	**41,102**	**41,206**
CAPITAL Purchases												
Delivery vehicle 5 t										35,000		
Production Pick-up										25,000		
Processing equipment										300,000		
Loan Repayment												
TOT. CASH OUTFLOW	**40,099**	**48,610**	**441,592**	**607,766**	**67,521**	**83,184**	**98,723**	**180,449**	**146,925**	**400,999**	**41,102**	**41,206**
Net Cash Flow	**(40,099)**	**(48,610)**	**(441,592)**	**(607,766)**	**41,895**	**135,648**	**261,215**	**815,033**	**603,506**	**(400,999)**	**(41,102)**	**(41,206)**
CLOSING BALANCE	**279,901**	**231,291**	**(210,301)**	**(818,067)**	**(776,172)**	**(640,524)**	**(379,309)**	**435,725**	**1 039,230**	**638,231**	**597,130**	**555,924**

Control elements in financial management

It is not possible to list all controls required in a seed business in a chapter of a book. Instead the aim is to highlight some of the risk areas and the key control areas that need to be addressed. The items discussed below are not exhaustive, but are presented because they are materially important to any seed business. If adequate controls and oversight of these issues is not given, the business may quickly run into problems.

Stock control

Seed companies maintain large stocks of seed and other consumables for lengthy periods of time, and consequently these are vulnerable to deterioration and loss. Stocks should therefore be maintained in secure enclosures and stock control procedures instituted. Each stock item ought to have a stock or bin card that provides a means of recording current stock quantities and additions and withdrawals of stock. Regular stock taking, at least monthly, is an important means of control. Stock sheets that enable efficient stock taking, and designed so that in addition to the stock quantity, the stock location, crop, variety, package size and year of production is noted provides useful information to managers. The stock records are then reconciled with deliveries and sales (Table 6.9) to cross check the theoretical stock level (according to accounting records) with the actual stock (according to the stock take).

Any differences between the theoretical stock level and the actual stock count must be investigated promptly. A small difference may be due to processing losses, especially where the stock includes unprocessed and processed seed. A large difference may indicate:

- fraud,
- error in counting, or
- misplaced stocks.

Table 6.9 Example of a monthly stock reconciliation.

Crop: Maize	Variety: Babungo
Pack Size: 10 kg	Production Year: 2008
Opening Stock as at 31 March	35
Add Deliveries in April	625
Less Sales in April	460
Theoretical closing stock as at 30 April	200
Quantity as per stock take	196
Difference	4

Cash controls and other systems of internal control

The management of cash in a business is critical to success. At the heart of this is a good accounting system that ensures that all transactions are recorded and reconciled with bank and cash balances on a regular basis.

On the sales side of the business, all sales must be invoiced with quantity and value of items sold being recorded. The physical and monetary amounts are then entered into stock records and accounting systems accordingly.

Cash sales receipts ought to be banked daily, while credit sales should only be made with credit-worthy customers, and these must be managed to ensure credit limits are not exceeded while insisting on timely payment.

Monitoring the age analysis of debtors, amounts owed and instigating debt recovery will help to minimize bad debts.

On the expense side, every purchase must be according to company policies, which usually require the following:

- All purchases must be authorized by appropriate managers according to pre-set budgets on the basis of two or more quotations.
- Identification of and selection of preferred suppliers.
- Issuing of an official order for the goods.
- Purchase of goods by cheque or on credit for purchases over a certain value, or with cash for low value items.
- Issuing of a "Goods Received Voucher" upon receipt of goods, with a cross-check to invoice and order details.
- Entering of goods received into stock records.

The largest expense that a seed company will have is seed procurement. Since seed is usually obtained from contract growers, the management of contracts, delivery receipts and payment procedures forms a major component of financial control. Upon delivery of seed, a "seed receipt voucher" should be issued that specifies crop, variety, essential quality status (e.g., seed moisture and percent seed defects), total quantity and pack size. It is not unusual for a seed company to delay payment for seed until germination tests have been done on delivered seed. A payment policy must therefore be established and communicated with contract growers. If payments are not made to growers upon receipt of seed, a system of managing these creditors needs to be established.

Access to and use of credit to finance the business

Seed companies face a large annual cycle of cash flow, with significant expenditure demands at the time of seed procurement that is only recovered some months later during the relatively short seed selling season. Securing credit for a negative cash flow period is the principal way of ensuring that a company remains viable. The availability of credit to seed companies and the credit worthiness of a seed company are therefore keys to business success.

Both borrowers and lenders have their own views of credit and risk that need to reach a mutually understood level of congruency in any credit agreement. Lenders will normally drive the process of evaluating and meeting the credit need of borrowers, for they are in the stronger financial position and have other options by which to meet their objectives of profit achievement and risk minimization. Borrowers have the role of convincing lenders that the giving of credit will be a win-win relationship.

Lenders will make an evaluation of a prospective borrower's credit profile or worthiness, as well as the loan *per se*. With respect to the credit worthiness of a borrower, lenders will consider three things:

1. The security of the loan, as reflected particularly by the balance sheet of the borrower.
2. The repayment and income expectations, as reflected in the cash flow budget of the borrower.
3. Management ability and historic company performance, as reflected in the income statements, company profile, product portfolio, brand strength, market share, etc.

Furthermore, when lenders evaluate the loan itself, they will prefer loans that are both self-liquidating and asset-generating (Barry et al. 2000). Self-liquidating loans are those that will provide resources to the borrower to enable them to generate sufficient funds to repay the loan within the loan period. Loans given for seed production are more likely to be self-liquidating within the loan period than loans for capital equipment, which have long pay-back periods. An asset-generating loan is one that provides funds to the borrower to purchase productive assets. These assets provide the lender with some security, but assets vary in their ease of reclaimability. For example, a loan for seed cleaning equipment is an asset-generating loan, but seed cleaning equipment is not as easily reclaimable as a vehicle or land. Assets also depreciate with time and use, and so their value as a reclaimable asset declines from the date of purchase. Land does not devalue, whereas vehicles and seed cleaning equipment devalues relatively fast.

Loans that are both highly self-liquidating and asset-generating are most desirable to lenders (Figure 6.6). Conversely, loans that will not be used for asset purchase and that will not generate cash returns to the borrower are of little interest to lenders. Lenders will exhibit an intermediate preference for loans that are high in one criterion and low on another. Consequently, the borrower has to build a credit application that will meet the lender's lending and risk preferences, while at the same time demonstrate a high degree of credit worthiness through good business management.

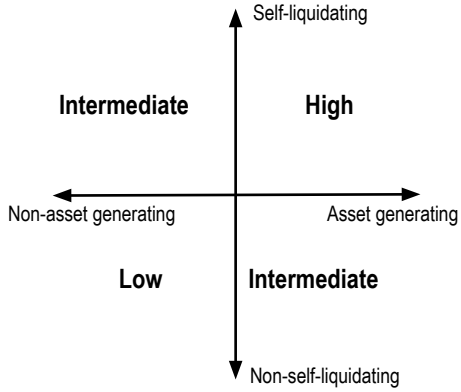


Figure 6.6 Lender preferences for combinations of loan characteristics.

Note: adapted from Barry et al.(2000).

When seeking to raise funds it is important to prepare a realistic cash flow which clearly shows the capacity to repay the loan. If the cash flow projection shows that the company is unable to repay the loan it will be almost impossible to convince a lender to advance the required money. If the cash flow is unrealistic, the lender might lose confidence in the manager's understanding of the business and consider the risk too high to provide a loan.

Nowadays, with the proliferation of lending institutions looking for business, it is always useful to have a number of lines of credit with a number of banks, so that when a payment is needed to be made, all lending institutions may be asked to quote. This will quite often result in reducing financing costs as the lenders compete for business.

Key thoughts

1. Managing the working capital cycle is key to success of a business. A seed company usually has a short period of the year when the majority of income is earned through sales, but operating expenses recur throughout the year and large expenditure is required to procure seed for sale ahead of the selling season.
2. The income statement is a means of evaluating a company's financial performance over a specified period. The statement provides information on the turnover, cost

of goods sold, gross margin, operating expenses and profit.

3. A review of income statements over recent periods provides information on how the company has performed over the longer term, and serves as a launching pad to plan future budgets and profit targets. The income statement may also be used to determine the break-even volume and prices of products and thereby establish the buffer the company has in the event of future turnover decline (due to reduced volumes, reduced prices or both).
4. The balance sheet is a statement of the company's financial condition on a particular date. It summarizes everything that the company owns (assets) and every amount that is owed to third parties (liabilities). From the balance sheet the company may determine the net worth, risk status, liquidity and degree of solvency.
5. The analysis of a company's financial status is carried out by examining the absolute figures on the income statement and balance sheet, and with the use of various ratios calculated from theses data, which are examined per se and in relation to previous periods and industry standards. Although these data and ratios are helpful in understanding the historical company performance, the reasons for the values of the figures and ratios are equally valuable in determining company performance and management requirements.
6. The cash flow refers to the movement of cash into and out of the company over time. For a company to remain viable inflows of cash must exceed outflows. Seed companies selling field crop seeds will have large annual fluctuations in cash flow, which will usually require credit support for company survival. Seed business managers need to consider ways of preventing significant negative cash flows.
7. Preparing budgets helps managers to plan and determine profitability and cash flow implications of production and marketing strategies, and provide a means to control future operations. The budgets of a company are therefore an important management tool to track and evaluate progress and profitability.
8. The two key control areas in a seed business are stocks and cash. Seed companies carry large volumes of perishable seed stocks that are at risk of deterioration and loss. Quality reduction of seed stocks can severely impact on stock value and sales potential. Cash management that ensures positive cash balances is fundamental to business success.
9. The seed business will likely require large annual borrowings to support cash flow fluctuations. Sources of finance will consider granting loans that are both highly self-liquidating and asset-generating. Business managers therefore have to develop strategic plans and budgets that will have a high degree of success of repaying loans while making the business profitable.
10. Managing a firm's financial strategy cannot be adequately done without a computerized accounting system that is maintained up-to-date and which captures all the key elements of the business. Managers who do not have current data on cash balances, income, expenses and profit performance will be at a great disadvantage.

7

Human Resource Management

Human resource management is a strategic component of business success, even though it has not been presented as one of the three strategic pillars that support the business vision. This is due to the cross-cutting nature of human resource management. The three principal strategies of marketing, production and finance all involve human resources. Consequently, in many respects, a business is only as good as the people involved, and managing the people of a company therefore constitutes an over-arching function of the business.

Not every seed company will have the resources to hire a Human Resource Manager, and therefore managers in production, marketing and finance will be expected to handle personnel-related decisions, including hiring, position assignment, training, compensation, compliance with laws and regulations affecting employees and the workplace, and ensuring safety and health of employees (and customers). This multiplicity of tasks requires individuals with strong organizational and inter-personal skills who can quickly shift from project or process management to people management without becoming overwhelmed.

Where a seed company is able to employ a Human Resource (HR) Manager to attend to the many issues related to staff (Figure 7.1), he or she must be accepted as an integral and strategic partner in the management structure of a firm. But, at the same time, the HR Manager must also be able to be an advocate of employees to management. This advocacy includes promoting a work environment in which people will be motivated, innovative, contributing and happy, while also fostering effective methods of goal setting, communication and empowerment through responsibility. Further, HR management is concerned with building employee ownership of the organization and its vision.

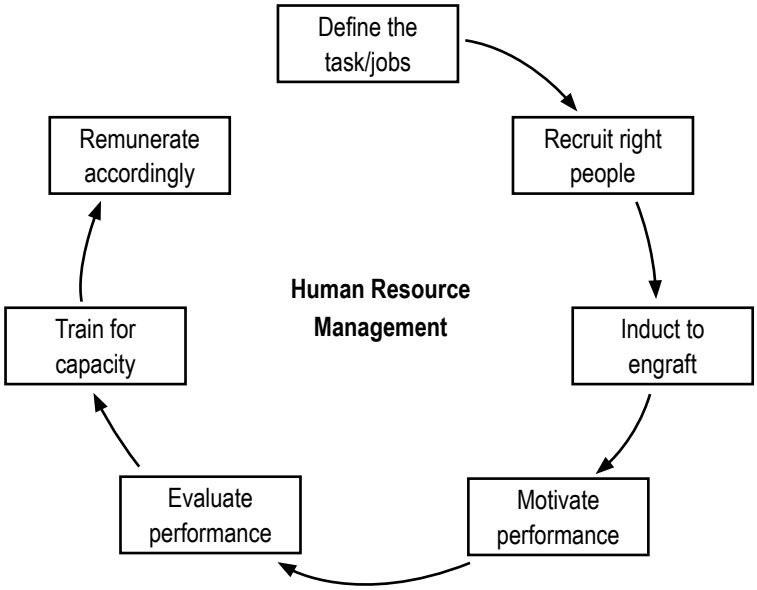


Figure 7.1 The principal functions of human resource management in a company.

The HR professional helps establish the organizational culture and climate in which staff have the competency, concern and commitment to serve customers well. In this role, the HR manager provides employee development opportunities, employee assistance programs, gain-sharing and profit-sharing strategies, organization development interventions, due process approaches to problem-solving and regularly scheduled communication opportunities. The constant evaluation of the effectiveness of the organization results in the need for the HR professional to frequently champion change. Both knowledge about and the ability to execute successful change strategies make the HR professional exceptionally valued. Knowing how to link change to the strategic needs of the organization will minimize employee dissatisfaction and resistance to change. The HR professional further contributes to the business by constantly assessing the effectiveness of the HR function. To support the overall success of the company, HR managers also champion the firm's mission, vision, values, goals and action plans amongst the staff. Therefore, the HR function cannot be overestimated.

Defining the tasks required in a seed company

As a firm develops its vision and defines the strategic framework to achieve that vision, managers will identify critical tasks within the organizational structure that will optimize the firm's human resources and their contribution. Each critical task needs to be defined and then personnel sought to carry out those tasks, and not vice versa. The critical tasks are defined in a job description to ensure that each person employed to carry out the

task is aware of the nature, responsibilities, performance expectations and skills needed for the task. The essential elements of a job description include:

- Position title (that concisely describes the job)
- Duty station (where the job is located)
- Reporting relationships.
- Objective of the position (what outcomes are expected from performance of the job).
- Tasks to be carried out, including the percentage of time expected to be spent on each task.
- Qualifications, job knowledge and skills required.
- Working conditions of the job, machinery and equipment to be used, and any possible dangers and risks associated with the job.
- Remuneration structure.
- Performance standards and appraisal.

Job descriptions are not static documents, but are dynamic as the business grows and develops, and as new technologies are adopted and utilized in the company. Consequently, regular review of jobs and tasks is important to maintain an effective and informed staff complement. As tasks change, positions may become redundant, redefined, or restructured, and staff holding the positions will need to be reallocated, retrained or retrenched. The overall aim is to ensure that the staff complement and organization is appropriate for achieving the vision of the company.

Recruitment of new employees

Employees are sought to fill essential positions in an organization. Positions and tasks must first be defined so that the best qualified person may be recruited to fill the position. It is not always necessary to employ new people or hire people on a full-time basis to carry out critical tasks, as there are alternative methods to fulfill needs, such as restructuring within the company, sub-contracting tasks to third parties and hiring temporary employees. Due to the seasonal nature of the seed business, the use of temporary or contract employees for certain tasks, such as those related to seed processing and for certain aspects of seed marketing (e.g., merchandisers) may be a good strategy to reduce annual wage costs.

With each new employee added to the firm, total costs increase. Generally, it is expected that efficiency will also increase with additional staff, particularly if staff are hired to perform critical tasks. However, this may not always be the case (Figure 7.2). For

example, for a given number of tons of seed produced or sold, the labor cost per ton of seed will be less if one person is employed for the task than if two or more persons are employed for that task. Labor cost efficiency only improves if total output is increased. Thus, if a new person is to be employed, he or she must contribute to the cost-efficiency or income-generation of the company; otherwise the company will simply make less profit and be less sustainable.

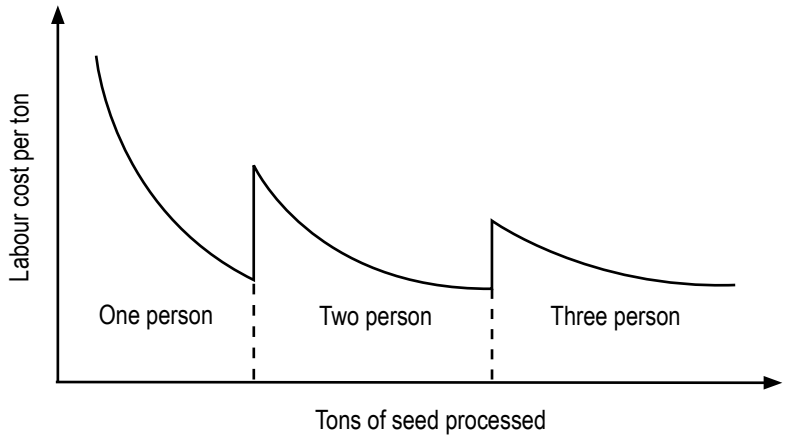


Figure 7.2 Schematic presentation of the effect of the addition of labor on the labor cost per ton of seed processed as the number of tons of seed processed increases.

Source: Adapted from Kay et al. (2008).

The process of recruiting personnel for defined jobs includes:

- Determining if there are any suitably qualified persons within the company to fill the position. If so, re-allocate the person to the new position, and recruit for the vacancy created.
- Advertising the vacant position in media that will most likely be accessed by potential candidates (see Box 7.1).
- Reviewing applications, checking references and shortlisting candidates for interview.
- Conducting structured interviews with candidates, where appropriate with a panel of interviewers. During the

Box 7.1 Key elements of a job vacancy advert

A good job vacancy advert should be simple, cogent and noticeable, and contain the following elements:

- Prominent job title.
- Concise job description covering key performance areas.
- Qualifications, skills and experience required.
- Brief description of the working conditions and risks associated with the job.
- Company name, logo and contact details.
- Application procedure.
- Closing date for applications.

Source: Adapted from Bester (n.d.).

interview, candidates are informed of the nature and expectations of the position. Each prospective candidate should be interviewed with the same set of questions, which normally include:

- Situational questions (e.g., education and employment history)
- Job knowledge questions (to evaluate whether the candidate has the required skills and abilities for the job)
- Job simulation questions (to evaluate the candidate's problem-solving capacity and personal relationship style)
- Employee requirements (to ascertain the expectations and needs of the employee). Candidates are also given opportunity to ask questions to the interview panel

- Potential candidates are evaluated, and the one considered most likely to meet the objectives and who best fits the qualifications, skills and experience required for the position is selected.
- The successful candidate is appointed and notified with a letter of appointment, indicating conditions of employment and date of engagement.

Induction of new employees

The process by which new employees are engrafted into the organization to become identified with and immersed into the culture and vision of the company is called induction. By the end of an induction process, an employee ought to know the vision of the business, how and where he or she fits in the organization, what is expected of them and what are the various rules, freedoms and responsibilities of employee and employer. In addition, the induction process offers an opportunity for the other employees of the company to familiarize themselves with the new employee and their role in the company.

The principal areas to cover in the induction process include:

- Vision and mission of the company
- Corporate values
- Corporate structure
- Roles and responsibilities of superiors and subordinates, reporting procedures
- Health and safety regulations of the company and position
- Marketing, production and financial strategies of the company
- Operational procedures
- Human resource policies (remuneration, leave, sickness, grievance procedure, disciplinary procedure, etc.).

Depending on the job description, the induction process may be a short and simple exercise or a lengthy and intensive procedure. Typically, the more responsible a position, the longer and more rigorous the induction process will be.

Motivation of employees

An employee is considered a resource, a factor of production, like money or machines, but the staff complement is made up of people, and therefore it is a different kind of resource. People are unique: they think, are creative, able to learn, have emotions and feelings, and can answer back! Therefore, human resources cannot be treated as mere money or machines.

A manager, whether he or she is the owner, department manager, foreman or supervisor, has authority over employees, and thus it is important for the manager to understand what this authority means. Authority means that the manager has power, or the strength to get things done. But, at the same time, it means that the manager has responsibility, in that he or she is accountable for the results and has responsibilities to the well-being and performance of employees. Power may be abused and responsibilities avoided, but both will lead to a breakdown in productivity and relationships with employees.

A relationship is formed whenever two people are in association. In any relationship, be it personal or work, there is mutuality. In other words, both parties, in this case the manager and the employee, have to contribute to the relationship to make it work. It also means that if the relationship breaks down there is always fault on both sides, and for reconciliation to occur, both sides have to act. Relationships in a business are different from those in social circles, since they are generally functional and not intimate. Nevertheless, the basic elements for a good relationship[3] are:

- *Appreciation:* in the work environment those in authority ought to appreciate those entrusted into their realm of authority. Such appreciation may be expressed by friendliness, kindness and seeking the best for the other person. The manager's role is to enable the employee to perform their job effectively and efficiently. Therefore, there is no room for cruelty, meanness, or jealousy in healthy relationships.
- *Trust:* Managers are in a position of trust and they have to trust their workers. Trust takes a long time to build and develop, and involves being reliable, honest and consistent, while giving employees opportunity to perform their work. Employees develop trust in their superiors when they see them doing what they promised.

[3]Adapted from H. Marshall, Ellel Grange, UK.

Sadly, trust may be destroyed in a short time through dishonesty, broken promises and lack of support, and once disrupted, trust is very difficult to restore.

- *Respect:* People need to be respected, whether they are a manager or an employee. Managers need to value their workers and show that they respect them. A manager will lose respect if he evades responsibility, or unduly or publicly criticizes his workers.
- *Understanding:* People desire to be understood, but it takes a lot of effort to understand someone, and our perceptions of people are often influenced correctly or incorrectly by external factors. This therefore depends greatly on how we communicate. The better that managers and workers communicate, the more they will understand one another, and the more they will be able to appreciate, trust and respect one another and so work together more effectively to achieve the company's vision.

It is thus clear that it takes special skill to manage and motivate staff and labor, but there are a number of points that may help to do this.[4] People are the most important resource in a business. They are creative, but they will only be as creative as they are allowed to be. Stimulating creativity in the right direction will increase both the individual's and the firm's productivity. Consequently, a manager must:

1. treat employees in such a way that they have no genuine cause for complaint or dissatisfaction, and
2. motivate employees so that they perform at a high level of productivity.

Employee expectations from management

Managers will only be effective to the extent to which they meet the expectations of their employees. Competent employees expect to be treated fairly and with respect, while being provided with the necessary facilities, equipment and systems to carry out their tasks. To be motivated, an employee expects to be able to participate in defining what is required of them, to have the opportunity to prove him or herself, and to know how well they have performed. If their performance is below expectation, employees appreciate help to improve, while if they have performed well, they expect a commensurate remuneration.

Employee performance levels

There are basically three levels of performance: minimum, expected and maximum; or below, as per and above expectation (Figure 7.3). Employees generally perform

[4]Much of this material is adapted from: Mol, A. 1984. *Motivating your farm labour.* Pretoria, SA: Folio Publishers.

at a minimum level or at a level below expectation when they are dissatisfied with the working conditions (i.e., poor working environment, lack of appropriate tools or low pay). When they are not dissatisfied, they will tend to work at the expected level, carrying out their duties faithfully. In this situation an employee has neither satisfaction nor complaints with the job. However, employees may do more than expected when they obtain satisfaction from performing their work. In this situation, the working conditions are fine, the pay is sufficient, relationships are good, but, most of all, the job is enjoyable and rewarding because there is an experience of success, there is responsibility and participation in decision-making, and there is recognition of achievement. Consequently, to encourage job satisfaction amongst employees:

- Meet the needs of the employees so that they are not dissatisfied.
- Give employees responsibility and build into their jobs motivating factors that will enable them to attain satisfaction from the job.

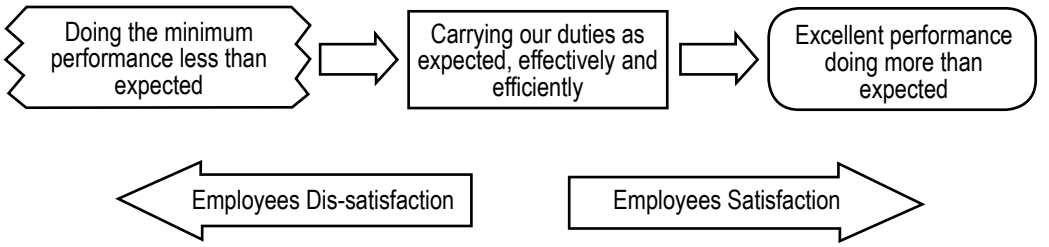


Figure 7.3 The three basic levels of employee performance, and the two principal drivers causing employees to perform below or above expectation.

The motivational cycle

When a person carries out a task with dedication because he or she enjoys doing it, that person is motivated. Thus, motivation involves creating an intrinsic condition that energizes, activates or moves a person's behavior in the direction of pre-determined goals (Box 7.2). The basic method of motivating a person in a job involves the following steps:

1. Identify the task needing to be done. *A job well defined is a job half done.*
2. Set measurable and attainable goals with the employee, which are related to the task to be done. For example,

Box 7.2 Some factors that either motivate or de-motivate employees

Motivators

- Job security and promotion
- Sense of achievement and usefulness
- Opportunity for personal growth
- Learning of new skills
- Good pay, benefits and status

De-motivators

- Poor working conditions
- Frustrating company policies
- Criticism, threats, unfair treatment
- Few opportunities for progress
- Unattainable targets and unclear standards
- Low pay and benefits

Source: Adapted from Bester (n.d.).

set the number of customers to be visited per week, or the quantity of seed to be processed per shift.
3. Give responsibility for decision-making to the employee. *People need to be identified with the problem or task if they are to be part of the solution or production thereof.*
4. Let the employee carry out the task. As the manager, do not interfere. The issue is not so much whether the worker is being active, but whether or not the task is being done, and that is the responsibility of the worker who has been given the task to do.
5. Measure the performance of the worker in relation to the objectives set in point 2. Give feedback to the workers on their performance. Were the goals achieved? If yes, give recognition and encouragement. If no, then determine the causes for failure to meet expectations and establish means to improve.

Performance appraisal

People who remain with a company usually do so because they find satisfaction in working with the company. In contrast, companies retain employees because the employee performs and contributes to the attainment of the vision of the company. Performance appraisal is one means of ensuring a long-term productive relationship between employees and the company.

Employment appraisal is a function of:

- Results or what was achieved in terms of measurable outputs (e.g., quantity of seed processed or the number of bags of seed sold). This is an objective measure related to the task(s) of the job, as defined in the job description.
- Behaviors or how the individual performed. This is related to the person's competencies, style, manner and appearance, and is therefore more subjective.

More weight should generally be given to the objective measures of performance, but the subjective component cannot be overlooked, especially with positions that involve much personal interaction, such as with sales' positions. Indeed, in such positions, the two aspects might be highly correlated.

The four phases of performance appraisal

Performance appraisal is an integral part of business activity. On the one hand, it is an on-going part of the manager-employee relationship, since daily performance is monitored and feedback in the form of encouragement or corrective measures is given. However,

performance appraisal is also a structured, formal activity that is usually carried out annually or semi-annually, especially related to remuneration and promotion. In order to ensure that the process is carried out satisfactorily to achieve desired results, four phases are typically involved:

- **Performance appraisal planning.** Employees need to know that formal performance appraisal will take place at certain times, and they need to know the format and criteria to be used for appraisal. This requires planning and communication of the procedures to employees. The appropriate place to begin this planning is with well-defined and understood job descriptions. Next, the employees, together with managers, set output objectives and milestones for the tasks defined in the job description. Finally, the dates and format of job evaluations are set and communicated to employees.
- **Execution of the performance appraisal.** Performance appraisals are not to be viewed as confrontations between managers and employees, but as an opportunity to make objective assessments of performance and provide constructive feedback in both directions. Consequently, the appraisal needs to be executed in a professional and edifying manner (Box 7.3).

Box 7.3 Common errors in rating employee performance

- Familiarity – overlooking issues because of friendship
- First impressions – being influenced by first impressions rather than establishing real issues
- Past performance – current appraisal being influenced by previous performance appraisals
- Recent performance – concentrating on most recent issues and not on the whole performance horizon
- Stereotyping – making a prejudiced appraisal based on personal perceptions about the employee

- **Assessment of the job performance.** The assessment of a person's performance must be as objective as possible, concentrating on quality, quantity, cost and timeliness of job outputs, and not on subjective or immeasurable aspects of an employee's conduct or personality. Each output goal is discussed with the employee and actual outputs compared to the goal. Allow the employee to provide input to the appraisal and respond to identified differences between observed and expected performance.
- **Review the appraisal.** At the close of the appraisal, review the agenda and discuss the completed performance appraisal with the employee. Listen and respond appropriately to the individuals' perceptions and feedback. Discuss the assessment of performance against the employee's strengths and achievements, weaknesses and deficiencies, and their development needs. Ensure full understanding of the

core message or outcome of the appraisal, and conclude the review by scheduling a performance planning meeting. Finally, complete the administrative requirements of the appraisal.

Dealing with poor performance from employees

Poor performance should not be tolerated in a business (Box 7.4). Not only does poor performance lead to lowered profits, but it will breed discontent, lack of enthusiasm and reduced commitment amongst other staff. When poor performance is encountered, never attack the person concerned or overlook the poor productivity. Rather, state the problem openly and offer assistance to finding a solution. Employees who perform poorly will often offer excuses—accept these but do not concentrate on or be side-tracked by them. Instead, look for solutions and identify what must be done to overcome the problem. Together with the employee, define what the employee must do to improve the output and what the manager must do to enable the employee to improve. Agree on a short-term goal and set a date to review the progress. Provide encouragement to the employee for any improvement in performance. If there is no improvement, repeat the process at least twice, adding a written warning the last time. If the worker cannot meet the required standard, then there may be no alternative but to institute disciplinary procedures.

Box 7.4 Be firm on standards, but soft on people

- Discuss with employees what they must achieve.
- Allow employees to make most of the decisions themselves.
- Use mistakes as learning experiences.
- Appraise the work through the measurement of end-results.
- Commend good performance and help to correct poor performance.

Training of employees to build competency

While every attempt is made to employ competent people into positions to carry out critical tasks, it is rare that everyone is perfectly qualified and proficient to perform tasks efficiently and effectively. Furthermore, as technology advances, employees may not have the necessary skills to make best use of the improved technology or new ways of doing tasks. Consequently, appropriate employee training is essential to any seed business. This may involve simply demonstrating improved techniques to employees, such as bag stacking with a new conveyor belt, or providing opportunities for specialized training, such as for new machine operation or software use. Whatever the situation, a manager should ensure that workers have the necessary skills to perform their duties in such a way to achieve not only quantity targets, but also the required *quality* of outputs.

Reasons for training and developing employees

Training is about improving the knowledge, skills and experience of an individual or group in order to increase productivity and make greater progress towards achieving the company's vision. Personal development is not restricted to training, but includes anything that may help a person to grow in ability, skills, confidence, tolerance, commitment, initiative, inter-personal skills, understanding, self-control and motivation. Training not only benefits the company, but it contributes to employee achievement and satisfaction. As employees obtain training and acquire new knowledge and job skills, they increase their market value, earning capacity and power. Training may also qualify employees for promotion to more responsible jobs and so provide a motivational stimulus to employees.

Box 7.5 The process of organizing training and staff development

1. Establish the training needs.
2. Set specific training goals.
3. Compile the training curriculum, specifying the training topics and outcomes (new skills or changes expected in trained employees).
4. Use effective training techniques and competent trainers.
5. Evaluate the outcomes of the training.

Effectiveness of training and development

For training to be effective it must be targeted to the specific needs of the company and employee (Box 7.5). A needs-analysis that examines the present skills' profile of employees and the skills need of operations will identify skills gaps and training objectives. Identifying suitable training providers may be difficult in some specialized situations, but time and effort spent on defining training needs, obtaining the best trainers and using the most appropriate training techniques will be worthwhile. Training may be provided either informally within the organization or formally by contracting trainers.

The effectiveness of training is not only measured by the cost-benefit of the training or the number of hours employees attend training sessions, but by the changes in behavior of employees, the increase in productivity and/or the improvement in quality as a result of the training. Furthermore, training and development effectiveness involves evaluating reductions in such factors as staff turnover, absenteeism, staff grievances and customer complaints.

Remuneration

Employees need to be rewarded for the work done, but determining the amount of pay for a given job is often difficult (Box 7.6). Nevertheless, compensation needs to be fair and sufficient for the work done. Basically, an employee should be paid according to what he or she is worth to the business, for the work performed and for commitment and performance. Remuneration is not a weapon, but a reward, and is only one aspect

of human resource management and employee motivation.

Box 7.6 Principles of wage and salary determination

1. Pay schedules should be based on job requirements in terms of skill, effort, responsibility and working conditions.
2. Salary levels should be in general agreement with industry standards and labor market, or defined according to prevailing labor laws.
3. Different jobs with equivalent requirements should receive equivalent pay.
4. The pay level for a job should be the same regardless of who is employed to fill the position.
5. Equitable means should be used to compensate individual differences in ability and contribution in a job position.
6. Pay structures should be transparent and communicated to employees, worker committees and unions.

Source: Adapted from Beach (1985).

Some of the factors to consider in setting salaries and wages include:

- **Supply and demand.** Jobs vary in the numbers of people available to fill the position, and consequently pay levels will vary accordingly. Where there are many people available for a particular position, a company may have greater leeway in the salary or wage attached to the position.
- **Scarcity of skills.** In the seed industry there are certain positions which require specialized skills, particularly related to seed production and processing. The scarcity of skills amongst people may require setting of higher salaries and wages to attract those people with the necessary qualifications and skills to meet the needs of the company.
- **Affordability.** Although salaries and wages will normally constitute a relatively small proportion of the total costs of a seed company, sustainable profits must still be made, and therefore companies are not at liberty to pay exorbitant salaries and wages. Since salaries and wages are a fairly consistent monthly expense they can have a significant impact on cash flow. Furthermore, salaries and wages are mostly accounted for under operational expenditure, and so influence operational profits.
- **Competitors.** Seed companies face competition for their employees from other seed companies and other businesses. Consequently, the level of pay offered to staff may be more influenced by external factors than internal considerations. To keep abreast with industry-wide salary levels, managers should subscribe to salary surveys, examine job adverts and discuss with colleagues in other industries as this will help to maintain salaries competitive and prevent dis-satisfaction amongst staff.

Remuneration of employees is not simply the provision of a time-based salary or wage. Some jobs may lend themselves to compensation based on piecework or an output-based scale, such as production staff or sales representatives. In most cases, the cost of employment goes beyond the salary or wage paid. Fringe benefits may also be provided as additional compensation to employees. These may include such benefits as medical

assistance, pensions, transport allowances, overtime allowances, annual bonus and so on. These benefits must be well-defined and specified to employees on appointment to avoid misunderstandings or false expectations at a later date. Furthermore, the tax implications of fringe benefits must be determined and communicated to employees. In certain jobs, employees may receive use of company assets to carry out their tasks, such as vehicles or phones. The conditions of use of these assets needs to be clearly specified, so that abuses or presumptuous use does not become a point of conflict with supervisors.

Key thoughts

1. Human resource management is an integral part of the strategic management of a business, since a business is no more or less than the people employed. Whether or not a seed company employs a Human Resource Professional does not diminish the need for all managers to be skilled in managing people for their good and the achievement of the company's vision.
2. Human resource management begins with identifying and defining the critical tasks of the company and establishing the qualifications and skills employees need to carry out those tasks. A company should not employ more staff than is absolutely necessary to carry out the critical tasks.
3. Recruitment of employees is a matter of seeking out people who can best fit into the positions required in the company. Once suitable people are recruited, they are inducted into the company to engraft them into the corporate structure, acquaint them with the company's vision, and establish them into their position. This will ensure that they are productive partners in the company's business.
4. To motivate employees, managers recognize that people may be dis-satisfied or satisfied with working conditions in the company. Dis-satisfaction breeds discontent and de-motivates staff, while employees who have no complaints with the working conditions and relationships in the workplace will generally perform to expectations. People will normally only perform above expectations if they obtain much satisfaction and personal fulfillment from doing their work.
5. The rapid rate of technological advancement requires that employees are continually developed in their knowledge and skills. Managers who identify training needs, provide training opportunities and promote skill development amongst their staff will improve employee performance and job outputs.
6. Staff compensation is a matter of matching the pay level with the qualifications, responsibilities and working conditions of the job, while maintaining congruency with the labor market and industry standards. Pay structures need to be well-defined and communicated to avoid misunderstanding and suspicion.

8

General Management of a Seed Company

Thus far, various components of seed business management have been covered in a systematic way. At the outset, the broad picture of some key factors necessary for the growth of the seed sector was presented. These included factors that the seed company has direct influence over, namely, the product portfolio, the development and maintenance of a seed grower base and the establishment of a distribution network to deliver seed to farmers. Amongst the external factors necessary for seed sector development, facilitatory national seed regulations, increased farmer productivity and functioning grain industries were considered priorities.

With these aspects in mind, a seed company needs a vision to guide the direction of the business. Without clear direction, no real progress is possible, or at least it will be difficult to measure progress. Nevertheless, to make progress, strategies are required. The three principal strategies for a seed company are those of marketing, production and finance. The marketing strategy formulates the sales goals for a product portfolio that is customer-focused and determines means of achieving those goals. The production strategy plans the way the seed required for sale will be produced, processed and packaged, with a quality that meets or exceeds customer expectations and regulatory requirements. Immersed between the marketing and production strategy is the research function. This latter seeks out improved, adapted and appropriate products for the market that may be economically and productively produced. The financial strategy determines the profitability of the combined marketing and production strategies together with the day-to-day operational costs of running the business. It also establishes means of financing, managing, monitoring and evaluating expenses, income, assets and liabilities.

To a large degree, every business is the sum of the people employed in the company. Human resource management should therefore not be neglected whatever the size and scope of the firm. Managers are particularly responsible in this area, as they identify critical tasks, recruit people into jobs to perform those tasks and institutionalize systems to compensate, motivate, evaluate and discipline employees.

Seed business management is therefore a comprehensive undertaking. A holistic appreciation of the seed business environment, along with a thorough commitment to the vision, a clear understanding of the strategies and dedication to daily managerial duties of the business is necessary to attain any measure of success. This final chapter provides some further insights into issues and requirements of the general management of a seed business.

Characteristics of a competent general manager

A General Manager of a seed business is involved in coordinating all the components of the company to achieve the vision. This involves formulating and implementing the financial, production and marketing strategies, monitoring and evaluating progress, and implementing improvements to ensure that the business progresses. Along with this is the management of the human capital of the firm. In order to fulfill this multi-tasking role, the following personal attributes are helpful:

- Courageous and visionary
- Confident and persevering
- Calm and rational under stress
- Willing to let employees take responsibility and do their work
- Ability to recognize and provide for the needs of employees so that they may be enabled to carry out their work effectively
- Able to communicate effectively for right understanding
- Results – and performance-oriented
- Pro-active rather than reactive
- Able to prioritize, putting first things first
- Constantly learning to obtain necessary knowledge and skills
- Able to concentrate on activities that are productive
- Work according to schedule and to a high standard

Within the context of a managerial position in an organization, two key behavioral variables have been identified (Blake et al. 1964). The one is a concern or passion for

production and output, while the other is a concern for people and their well-being. These two concerns may exhibit degrees of expression and their combination influences the culture and climate of the business (Figure 8.1; Box 8.1). Managers who exhibit a minimal concern both for the people in the organization and for production will likely inculcate similar attitudes amongst subordinates and colleagues, resulting in reduced production and low morale. Where managers portray opposite extremes of concern for people and production, corporate culture may follow. The organization will move towards a culture of a comfortable work environment (i.e., the "comfort zone" where friendship and good relationships are prized, while production will be expected to happen as a by-product of good relationships), or a focus on output alone will arise (where people are expected to work hard to produce outputs but are not expected to participate in work planning or decision-making). The best managerial style is where near equal emphasis is given to people and productivity. Human relationships and welfare is considered important, as is productivity output. To move towards this position where people have a common stake in production, managers need to first examine their own behavioral patterns, evaluate team effectiveness and diagnose major organizational problem areas. After this, corrective personal and organizational measures may be implemented so as to enhance the organizational culture for improved managerial effectiveness.

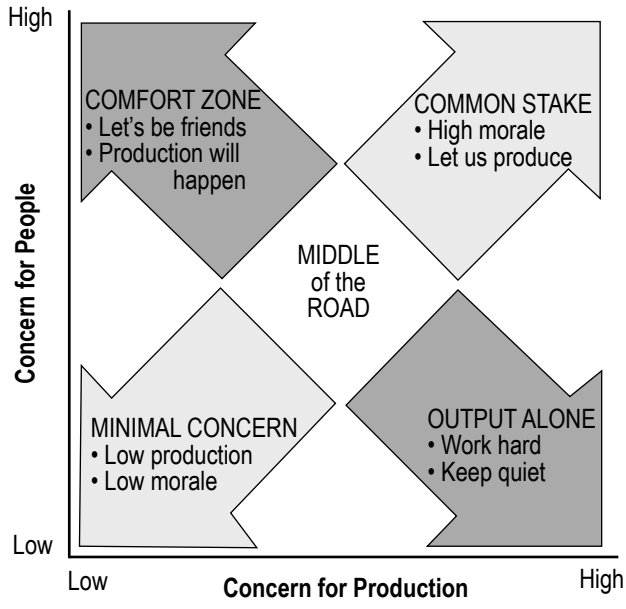


Figure 8.1 The managerial grid that illustrates the combinations of the degree of concern for people and concern for production on the organizational climate of the business.

Source: Adapted from Blake et al. (1964).

It is unusual for a manager to be thoroughly competent or able to cope with all the daily demands of managing the entire operation of a seed business, even a small one. The demands of managing the financial, production and marketing strategies are immense, especially as the business grows. Wherever a manager recognizes a personal weakness in one or more areas, or where there is simply insufficient time to give enough attention to each component, it would be wise to employ complementary people. Choosing the right people to employ into key managerial positions, indeed into any position in the company, is crucial to success. Take time to define the job, its functions, performance indicators, areas of responsibility and required qualifications.

When a new position is created and filled with a suitable person, the manager has to delegate some authority to the employee in the position. However, this delegation of authority does not imply a loss of control, which is a fear many managers have of delegation. Delegation brings about a different type of control—the manager no longer carries out the actual task, but supervises and advises the person doing the task. Thus, as a seed business grows, the senior manager is likely to become more and more involved in supervision of employees. In such situations, good managers are concerned with meeting the needs of the employees as they work at accomplishing their jobs. This requires good communication systems, clear reporting structures, measurable performance indicators, and a clearly understood and shared vision in the company. Above all, leadership ability is required of a competent general manager.

Leadership styles

Managers and leaders are not equivalent. Strictly speaking, managers are concerned with the management of the technical aspects of a business, such as things and processes, while leaders lead people (Beierlein et al. 2008). Managers principally aim at achieving high technical efficiencies, by doing the right things well. They also ensure that subordinates have the necessary environment, tools and resources to achieve output targets. Leaders, on the other hand, seek to attain the greatest possible good from the activities of people. General Managers of seed businesses combine both roles, but leadership is the greater component since technical management is usually delegated to subordinates.

Box 8.1 What are the organizational culture and climate?

The concept of organizational culture refers to the underlying set of principles and values that are maintained and upheld in the company. It is the way things are done in a company. The climate, on the other hand, refers to the daily interactions and nature of relationships amongst people in the company. The two aspects of culture and climate interact and influence employee motivation and satisfaction, and also affects the way customers and the world perceive the company.

Source: Adapted from: Burke and Litwin (n.d.)

There are as many leadership styles as there are leaders, and there will always be a leader, either good or bad. Whether managing a small team of marketing personnel or a large international corporation, a manager's leadership style is crucial to team and company performance. A leader's behavior has a significant influence on an employee's emotions at work and consequently contributes to the organizational climate. In brief, the leadership style means the patterns of behavior that a leader uses under different situations. Influenced by our internal motives, values, cultural environment and the way we were taught, each person unconsciously tends to have some natural style of leadership.

Management specialists have developed various classification schemes of leadership styles. Daniel Goleman (2002) in his book Primal Leadership describes six leadership styles. None of these is good or bad, but each has its time and place to be used. An outstanding leader is able to use a variety of leadership styles and skillfully switch between them, depending on the circumstances encountered.

The visionary style

A visionary leader motivates through presenting to the team well-articulated long-term vision and solicits employee perspectives on the vision. The leader uses a balance of positive and negative feedback, directs where to go but not how to get there, and so leaves space for employees' creativity, innovation and struggle to progress towards the vision. Performance of employees is evaluated in relation to the vision. This style is suitable when new direction and strategies are needed or when a new team is formed. When used well, this style will have a long-term positive effect on the organizational climate. The visionary style is not suitable in emergency situations or when trying to motivate more experienced experts or peers.

The coaching style

Leaders who have this style help employees to find and understand their unique strengths and weaknesses, while tying them to professional goals and aspirations. Such leaders also encourage long-term professional development of team members. The leader delegates challenging assignments, provides on-going instruction, as well as feedback and may temporarily trade-off immediate standards of performance for long-term development. This is a suitable style when building an individual's long-term skills and capabilities, and it may have a positive long-term effect on team performance.

The affiliative style

The person who has this style of leadership is most concerned with promoting friendly personal interactions, creating harmony within the team or organization, and tends to avoid any performance-related confrontations. The leader puts more emphasis on addressing employees' emotional needs over the work needs, pays attention to and cares for "the whole person", often stressing things that keep people "happy" and comfortable. The affiliative style boosts morale and is suitable when accompanying the visionary style, to motivate during stressful situations or temporarily as a kind of reward. When used improperly, it may avoid emotionally distressing situations such as negative feedback or cause detachment from organizational and production goals.

The democratic style

The democratic leadership style builds commitment via employee participation and collective development of decisions, promotes teamwork, listens and values input and trusts in collective wisdom. Employees are given freedom to develop the appropriate direction for themselves and the given task. The democratic style helps to generate new ideas, build consensus (collective buy-in) and provides space for employees' concerns and standards. When done badly, however, it may result in many meetings and look like lots of listening but very little effective action.

The pace-setting style

These leaders have a strong drive to achieve and lead by example. They build challenging and exciting goals for people, expecting excellence and often exemplifying it themselves. They have high standards and expect that team members know the rationale behind what is being modeled. However, they tend to hesitate to delegate and may take responsibilities away from team members if expected performance is not forthcoming. If necessary, they will roll up their sleeves and rescue the situation themselves or give detailed task instructions when employees experience difficulties. Using this leadership style gets short-term results but over the long-term, this style can lead to exhaustion and performance decline. It is best used for results from a motivated and competent team.

The commanding style

The commanding leader gives lots of directives, controls activities tightly, micro-manages and expects immediate employee compliance. These leaders rely on negative or corrective feedback and motivate by stating the negative consequences of non-compliance. This approach is suitable in times of crisis when unquestioned rapid action is needed and with problem employees who do not respond to other methods of motivation. If used

too much as a main leadership style, it de-motivates, causes exhaustion and disharmony in the team.

Why do some seed businesses fail?

That businesses may fail is not impossible. Failure is a possibility and a risk that every seed business manager must consider and guard against. To put it bluntly, a common reason for business failure is incompetence. Incompetence simply means that a person lacks the necessary skill to do or carry out a task. Thankfully, incompetence may be overcome! Training, and the implementation of learned skills, can overcome incompetence and thus help prevent a business from failing. Thus, in theory, a business does not have an excuse for failure, for there are ways and means of gaining appropriate knowledge, skills and experience and applying these to the business situation. Of course, there are other factors that may cause businesses to fail which may be external to the business, such as drought or national economic woes. However, even with these factors, good managers should anticipate them, make and implement plans to overcome them.

> "Poor management is the greatest single cause of business failure."
> *Steve Muhlhauser*

Common areas of incompetence that may cause businesses to fail include:

- Inefficient control over costs
- Inadequate quality of product
- Lack of strategic planning
- Mismanagement of cash
- Under-pricing products
- Employing the wrong people
- Bad public relations with customers
- Bad relations with suppliers of consumable materials
- Inability of management to make decisions and act on them
- Inadequate control of business finances
- Taking on too much credit and being unable to repay
- Granting too much credit to customers
- Consignment selling arrangements with stockists who do not manage stocks well or who do not pay for stock they have sold

With respect to seed companies, other factors that may lead to failure are:

- Product stagnation, i.e., no development or acquisition of new varieties

- Poor maintenance of source seed stocks (breeders' seed) leading to product contamination and genetic variability
- Poor storage facilities that cause seed quality deterioration
- Not keeping abreast with agricultural developments and trends so that varieties become redundant
- Poor relations with seed growers

The results of incompetence and all the factors listed above generally lead to the three most common death-nails of a business, namely, *lack of cash (liquidity), low profit margins and too much debt (insolvency).* Low profits simply affect the ability of the company to grow, invest and keep pace with inflation. Too much debt, and especially risky debt, merely impacts on cash resources to run the business. Without cash, a business is basically unable to function on a day-to-day basis, even if the potential profits from repaid debts would be large. These lists should therefore serve as checklists to measure a seed business against. If some of the items in the list are evident in a business, this should serve as a warning and corrective measures taken.

Developing a business plan

This book has presented key aspects of seed business management, such as developing a company vision, defining the marketing, production and financial strategies, and establishing human resource management principles. General Managers have the task of combining these aspects into a coherent business plan that will be used to guide business activity and serve as a motivator for credit applications.

When plans are not made or documented, the manager loses control of the business future, and subjects the business to the vagaries of crisis management, instead of planning to make things happen that will progress the business towards the vision. A common saying in business is, *"If we fail to plan, we are planning to fail!"*

Writing a business plan is important because:
- It forces the manager to arrange strategies and activities in a logical order.
- It forces the manager to think realistically about the business.
- It may help avoid going into activities that are likely to fail.
- It will become the working action plan, giving guidelines on how to run and expand the business.
- It will provide information needed by others, especially when wanting to borrow money.

There are short-term plans and long-term plans. Most managers make short-term plans, for example, on a daily basis to get tasks done. Few managers, however, prepare and document long-term plans. Long-term plans are important to maintain control of the business and to help the business grow and develop. The ***Business Plan*** is a long-term plan, and must therefore be prepared with much systematic forethought.

A *Business Plan* may be written up in any form, as there are no rigid rules. Nevertheless, it should be succinct, understandable, logical and well-written. The basic outline of a business plan may have the following main sections:

- Introduction,
- Summary,
- Business vision,
- External business environment review,
- Internal business analysis, including SWOT analysis and other tools,
- Marketing strategy,
- Production strategy,
- Financial strategy,
- Management and administration,
- Funding requirements and proposals, and
- Conclusion.

Business organization

Businesses may be organized in a number of different legal and organizational formats. The most common forms of legal organization are sole trader (or proprietorship), partnership, cooperative, private limited company or public company (corporation). Once a business begins operations with one legal format, it need not necessarily remain in that form. Businesses may change their legal status over time and according to circumstances.

An example of such change in legal status is Seed Co Limited, a multi-national, but indigenous seed business in Africa (McCarter 2002). The origins of Seed Co Limited date to 1940 when the Seed Maize Association was formed in Zimbabwe amongst farmers to produce and market popular open-pollinated varieties. As the market for maize and other crop seeds grew, the Seed Maize Association merged with another Crop Seeds Association to form the Seed Co-operative Company of Zimbabwe Limited, essentially a registered cooperative of seed-producing farmers. The Seed Co-op, as it became known, grew further, and in 1996 the company was renamed Seed Co

Limited and was listed on the Zimbabwe Stock Exchange. Since then, the company has expanded into a number of African countries establishing regional business units under the framework of the Seed Co Group.

The choice of legal structure is influenced by the number of people who start a business, by the size of the business and by the way the owners wish to subscribe, attract, conserve and distribute equity capital. The decision of the most appropriate legal structure also takes cognizance of government regulations and tax laws concerning business operation. Hence, the advice of lawyers and tax consultants is helpful to owners deciding on the legal form of operation. What follows here is a brief description of the principle aspects of alternative organizations.

Sole trader

This is the most common way to begin and operate a small business. The business is established, owned and managed by one person, even though the business may employ workers. Anybody can run a business as a sole trader and it requires little or no legal formalities. Sole traders usually have a name like *P. Mwangi T/A Super Seeds* (where the "T/A" stands for *trading as*).

Advantages:

- The business is independent and the owner has maximum management control.
- It is simple and flexible.
- Sole traders require little capital to start off.
- The owner is personally involved and directly responsible, and therefore there is strong motivation to succeed.

Disadvantages:

- The owner is directly responsible and liable for the debts of the business, so if there is a debt crisis, the owner may lose some of his personal possessions to repay loans.
- It often suffers from a lack of working capital.
- It may lack continuity if the owner goes away.

Partnerships and cooperatives

A partnership is an association of two or more persons who establish and manage a business as co-owners. These may also be termed "Joint Ventures." Partnerships are usually restricted to a small number of co-owners, while co-operatives commonly comprise

many co-owners. These forms of business ownership are common in community-based seed schemes.

Each member or co-owner of a partnership or co-operative usually pays an amount into the business to generate the initial working capital. The terms of the co-ownership are set out in a partnership agreement or constitution. These agreements clearly define the roles and responsibilities of each partner or member, and how profits or losses, assets and liabilities are to be shared between owners.

Advantages:

- Partnerships enable a new business to raise initial working capital.
- Partners can contribute experience, knowledge, skills, resources and ideas to the business.
- Partnerships are a good model for small-scale seed production, especially if the farmers are in a contiguous area, for it enables the whole group to grow one variety, thereby minimizing contamination of seed.
- Partners share responsibilities and risks.
- Partners share in the profits.

Disadvantages:

- All the partners are directly responsible for the debts of the business.
- It is sometimes difficult and tedious to make decisions.
- Disagreements amongst partners can ruin the business.
- One partner can do much harm to the business—this is particularly true for a seed business in the case where one farmer introduces another variety of seed into the production scheme, thereby contaminating the whole crop.
- Loss or departure of partners can cause problems in distribution of assets and capital.

Incorporated companies

In some instances, individuals or small groups of people may find it advantageous to register their business as a limited liability company. By doing this, the business becomes a legal entity in itself, separate from the owners, even though the owners still have direct control over the business as shareholders. Thus, the company itself, and not the owners, defines the business and is liable for debts. In other words, the liabilities of the company are limited to the assets of the company. This gives maximum legal protection to the owners. The shareholders are the "Directors" of the company and have a defined share in the business. They may appoint managers to run the business on their behalf.

This form of legal structure also provides continuity to the business as ownership may be transferred without terminating the business operation. The business may only be terminated by legal action.

The process of incorporating a business is complicated and costly, and thus most small businesses neither operate in this way, nor do they begin this way. However, if a small business expands, it may well be worth formalizing the business into a limited liability company. Indeed, for an entrepreneur serious about establishing a seed company, it is probably best to begin by forming a registered company, with the advice of a competent accountant or lawyer.

How to make a community seed production group successful

Cooperatives and farmer groups are often formed to produce and distribute seed on a communal basis. Farmer-groups are generally a good idea, because they encourage the pooling of skills, labor and resources, while also increasing buying or selling power through collective action. Furthermore, in seed production, a group enables smallholder farmers to achieve required isolation if all members in a contiguous area grow the same variety or agree on suitable time-isolation planting dates. However, the formulation and management of groups is often more complex and difficult than a solely-owned business. A basic key to success is to strive to maintain unity and cooperation amongst members. This may be achieved through recognizing the following points:

- Groups work best when they consist of people with similar backgrounds, circumstances and objectives.
- Rules governing the group's activities should be decided upon by group members and be written up in a constitution accepted by all in the group.
- Ideally, every member of a group should have a responsibility, since everyone has something to contribute and everyone has a need to be needed.
- Each member has his or her own objective or agenda. Seek to incorporate these into the objectives of the group so that all members are satisfied. However, be careful that personal agenda do not interfere with or prevent the group objective from being achieved.
- A good leadership structure is essential. Leaders are most effective when they serve and meet the needs of those whom they lead.
- Open and honest communication which seeks to understand before trying to be understood will engender transparency and trust amongst members.
- Solving conflicts as soon as they occur will reduce dis-satisfaction amongst members. Conflicts that fester will tend towards disunity. When solving conflicts, seek solutions in which all parties win. Avoid solutions in which one party wins

and the other loses. Win-win solutions may be achieved without compromise, but they require hard work and a willingness by all parties to seek the best solution. Remember to attack the problem, not the person.

Risk management

The agricultural business environment is a particularly uncertain one. Not only do agri-businesses and farmers face the vagaries of climate, but the socio-political and economic environment is constantly changing. Furthermore, the long product life cycles and production processes do not provide companies with short-term agility. Seed business managers have to plan over long planning horizons. Therefore, it is hard to respond quickly to rapid changes in the environment or economy.

Businesses face both risk and uncertainty. Uncertainty reflects situations where the outcome is unknown. There is little that can be done about uncertainty except to attempt to build into the company's strategy a degree of resilience. This may include aspects such as having healthy asset:liability ratios, keeping tight control of credit sales, sustaining good levels of liquidity, and maintaining buffer stocks of seed to counter catastrophic weather conditions or to take advantage of unexpected upturns in sales. Some of these conservative measures, however, may impede or limit growth or expansion plans.

Risk describes a situation in which managers are able to determine the probability of possible outcomes when certain events occur. In maize farming, for example, the probability of yield loss from drought is greater if drought occurs over the flowering period than during the vegetative period. Or, the probability of seed deterioration is high if seed is stored in moist warm environments. This indicates, and it is well understood, that agri-businesses face the greatest risks from weather-related conditions. However, seed businesses may also face financial risks, particularly regarding borrowing or lending money; legal risks with respect to seed performance or accidents; and personnel risks in the event of the departure or loss of employees.

Key to managing risks is a regular scan of the business for potential risks, estimate their likelihood of occurrence and their possible degree of impact on the business, and define risk prevention or mitigation strategies to deal with the risk (Table 8.1). Each manager in the company becomes responsible for implementing the risk prevention or mitigation strategy. Risks that are considered to have a high impact and a high likelihood of occurrence are particularly emphasized and frequently reviewed to ensure that the company is doing all that is necessary to reduce the possibility of the risk occurring.

Table 8.1 Example of a framework for establishing a risk management strategy in a seed business, with two risk management cases.

Objective	Risk	Process system	Responsible Manager	Recommended risk prevention or mitigation	Impact (Low, Medium, High)	Likelihood (Low, Medium, High)	Mitigation plans
Staff motivation	Staff de-motivated with consequent reduction in seed processing output	Human Resource Manage-ment	Seed Processing Manager	Good communication between manager and plant supervisors	Medium	Medium	Weekly processing planning meetings
				Appropriate processing targets set	High	Medium	Plant manager to review weekly processing requirements
New product development	Inappropriate products developed	Research	Research Manager	Marketing goals communicated to Research Department	High	Low	Bi-annual meetings to be held between marketing and research departments

Time management

Business plans must be implemented in a timely manner. Timelines and milestones help managers to monitor implementation and attainment of goals. Time should be managed rather than allowing time to manage us. Time is a resource that can either be used efficiently or wasted. Time itself does not cost anything, but its misuse can be an unrecoverable expense. Here are two important tips for consideration:

1. Schedule time carefully. Work backwards from deadlines, setting realistic times or dates when certain tasks must be completed. Communicate these to all involved.
2. Prioritize activities. Priority setting is the process of ranking tasks from the most important to the least important. Be careful not to allow the urgent to override the important. Important tasks are those that will make a significant contribution to the value of the business. Urgent tasks usually do not contribute much to business success, but they can consume a lot of time.

Some important dos and don'ts related to time management:

DO	DON'T
• List and prioritize tasks to be done	• Attend useless meetings
• Stop talking so much	• Spend time talking about useless things
• Be on time	• Be late
• Tackle the most important tasks first	• Waste time

Improving business performance

All managers should aim to improve their business performance. There is always the possibility of doing things better, more effectively or more efficiently. On a continuous basis, critically assess each of the three strategies of the business as they are being implemented, seek feedback and input from employees and customers, and use this information to revise plans, improve strategies, enhance sales, reduce costs, improve quality and increase profits. Continuous improvement is a mark of a good company.

Performance that is measured can be managed. Key performance indicators (KPIs) are therefore a useful means of monitoring company performance (Table 8.1). KPIs may be calculated for a range of company activities, statuses and outputs. It is important to note, however, that only those KPIs that are likely to make a significant impact on company performance should be recorded and tracked. Targets for these may be set and actual performance evaluated against the targets. The reasons for any observed positive or negative differences serve as learning opportunities and provide a stimulus for improvement.

Planning, implementing, monitoring and improving business performance is a learning process. The first plan may not fit together perfectly or in its initial implementation, a strategy may not work perfectly. However, by learning from the experience, the second and subsequent iterations can be improved. During implementation, the manager must be willing to be flexible and adaptive, taking challenges, mistakes and uncontrollable factors into rational account. Above all, do not lose hope. Persevere. The rewards of adapting to change, accommodating the unexpected, and exploiting new opportunities are well worth the effort—not just for the personnel of the seed company, but also for all those who are the business' customers. A seed business that is profitably supplying quality seed of improved, adapted and appropriate varieties to farmers will make a significant difference to farmer livelihoods and national economies. This is the vision for the seed sector; this is the goal to which we should strive.

Table 8.2 Examples of key performance indicators relevant to a seed company.

KEY PERFORMANCE INDICATORS	CURRENT	TARGET
MARKETING		
• Product life-cycle or age analysis per variety		
• Volume and contribution to total sales of each product		
• Quantity and value of seed sold through various distributors		
• Number of field days and farmer attendance		
• Marketing costs per tonne of seed sold		
• Selling price per variety and pack size		
• Ratio of selling price to cost of goods		
• Ratio of selling price to grain price		
• Market share		
• Number and value of complaints		
RESEARCH		
• Ratio of trial to nursery rows		
• Number of varieties in preliminary, intermediary and advanced testing		
• Number of varieties in registration process		
• Number of varieties registered annually		
• Trial and nursery row costs		
• Variety performance in National Trials		
PRODUCTION		
• Gross current production of each variety		
• Average yield per variety		
• Seed yield and production of each seed grower		
• Average cost per tonne per variety		
• Seed quality indicators, such as percent rejections, average germination percentage per variety, average defect percentage per variety		
• Mileage per Seed Inspector		
PROCESSING and WAREHOUSING		
• Man hours per ton of seed processed		
• Cost per ton of seed processed		
• Electricity cost per ton of seed produced		
• Processing gains/losses per crop		
• Equipment downtime		
• Stock reconciliation losses		
• Seed quality indicators, such as germination percentage		
FINANCE		
• Timeliness of presentation of management accounts		
• Return on capital employed		
• Gross margin per product		
• Liquidity ratio		
• EBIT as a percentage of turnover		
• Cash flow		
• Expenditure on Research, Production, Processing, Marketing and Overheads as a percentage of turnover		
• PERSONNEL		
• Vehicle running cost per kilometer		
• Vehicle fuel consumption and monthly mileage		
• Telephone costs (cell and land line) per employee		
• Absenteeism per employee		
• Training days per employee per year		
• Staff turnover		

Key thoughts

1. The general management of a seed business involves coordinating all the components of the company to achieve the vision. Leadership skill is a notable requirement for advancing the company towards the vision.
2. Competent leaders have attributes such as vision, communication skills, zeal and perseverance, while they are able to balance and maintain a high concern for people and a high concern for production.
3. Failure in business has its root cause in incompetence. However, incompetence may be overcome through education, communication and application of knowledge. The three main financial factors needed to keep a business alive and growing are liquidity, solvency and profitability.
4. Business plans that are prepared and written up provide a sound basis for management, while also serve as means to secure funding for operations and/or growth.
5. Seed businesses should choose a legal structure that will give the company the best opportunity for securing investment, providing protection to owners, means of optimal management of the business, and for distributing equity and profits amongst owners.
6. Businesses face both risk and uncertainty. Incorporating a degree of resilience into the company will help avert impacts of uncertain events, while evaluating the probable impact and likelihood of risks and instituting mitigating actions for each potential risk will help to reduce the possibility of risks occurring.
7. Time is a valuable commodity that cannot be wasted without dire consequences.
8. Continual improvement of a business' performance may be achieved tracking key performance indicators, and applying lessons learned from the changes noted.

References

Andrews C.H. and E.R. Cabrera, 1995. Seed quality. Bulletin 1033, Mississippi State University.

Anonymous. 1991. *Administrative training manual introductory level.* Santa Cruz, Bolivia: Mennonite Economic Development Associates (MEDA).

Association for Official Seed Analysts (AOSA). 1983. Seed vigor testing handbook. Ottawa, Canada; Association for Official Seed Analysts.

Attavar, M. n.d. The S-factor: maintaining high seed quality during storage. AS&PM Magazine.

Barry, P.J., P.N. Ellinger, J.A. Hopkin, and C.B. Baker. 2000. *Financial management in agriculture.* Danville, IL: Interstate Publishers, Inc.

Beach, D.S. 1985. *Personnel: The management of people at work.* Fifth edition. New York, NY: Macmillan Publishing.

Beierlein, J.G., K.C. Schneeberger, and D.D. Osburn. 2008. *Principles of agribusiness management.* Fourth edition. Long Grove, IL: Waveland Press, Inc.

Bester, C. n.d. *Human resource management.* Pannar, Greytown, South Africa.

Blake, R.R., J.S. Mouton, L.B. Barnes, and L.E. Greiner. 1964. *Breakthrough in organization development.* Business Classics: Fifteen Key Concepts for Managerial Success. Boston, MA: Harvard Business Review.

Burke, W.W., and G.H. Litwin. n.d. *A causal model of organizational performance.* Chorelywood, Hertfordshire, UK: NG Associates.

Campbell, P. 2004. *Never run out of cash.* Tomball, Texas: Grow and Succeed Publishing, LLC.

Chen, C.C., and C.T. Tsau. 1994. Effective factors on equilibrium relative humidity of agricultural products. *Journ. Agric. Res. China* 43 (1): 93–112.

de Meyer, n.d. CIMMYT seed experiences. Successes, constraints and lessons for the future. CIMMYT-Mexico.

FAO. 2003. Compendium of Agricultural – Environmental Indicators 1989-91 to 2000. Statistics Analysis Service, Statistics Division, Food and Agriculture Organization of the United Nations, Rome

Goleman, D., R. Boyatzis, and A. McKee. 2002. *Primal leadership: realizing the power of emotional intelligence.* Boston, MA: Harvard Business School Press.

Hallauer, A.R., and J.B. Miranda. 1988. *Quantitative genetics in maize breeding.* Ames, IO: Iowa State University Press.

Hassan, R.M., M.Mekuria, and W.M. Mwangi. 2001. Maize breeding research in eastern and southern Africa: Current status and impacts of past investments by the public and private sectors, 1966–1997.Mexico, D.F. (Mexico): CIMMYT.

Henderson, B.D. 1973. *The experience curve – reviewed. IV. The growth share matrix of the product portfolio.* Boston, MA: The Boston Consulting Group.

Heisey, P.W., M.L. Morris, D. Byerlee, and M.A. López-Pereira. 1998. Economics of maize hybrid adoption. In M.L. Morris (ed.), *Maize seed industries in developing countries.* Mexico, D.F.: CIMMYT.

Hill, C.W.L., G.R. Jones, P. Galvin, and A. Haidar. 2007. *Strategic management - An integrated approach.* John Wiley & Sons

Hutt, R.W., and W.A. Stull. 1992. *Marketing: an introduction.* South Western: Cincinnati.

ISTA (The International Seed Testing Association). 2008. International rules for seed testing. Edition 2008. Bassersdorf, Switzerland.

Janssen, W. 2001. The context of agricultural research planning. In G.Gijsbers, W. Janssen, H.H. Odame, and G. Meijerink (eds.), *Planning agricultural research: a source book.* New York, NY: CABI Publishing.

Jayne, T.S., and G. Argwings-Kodhek. 1997. Consumer response to maize market liberalization in urban Kenya. *Food Policy,* 22 (5): 447–58.

Kaplan, R.S., and D.P. Norton. 1996. *The balanced scorecard: translating strategy into action.* Boston, MA: Harvard: Business School Press

Kay, R.D., W.M. Edwards, and P.A. Duffy. 2008. *Farm management.* Sixth edition. New York, NY: McGraw-Hill.

Kirsten, J., and K. Sartorius. 2002. Linking agribusiness and small-scale farmers in developing countries: Is there a new role for contract farming? *Development Southern Africa 17(4).*

Kohls, R.L., and J.N. Uhl. 2002. *Marketing of agricultural products.* Upper Saddle River, NJ: Prentice-Hall, Inc.

Krull, C.F., J.M. Prescott, and C.W. Crum. 1998. Seed marketing and distribution. In M.L. Morris (ed.), *Maize seed industries in developing countries.* Mexico, D.F.: CIMMYT.

Langyintuo, A.S., 2005. Functioning of cereal banks and inventory credit programs in West Africa: a trip report. International Maize and Wheat Improvement Center (CIMMYT) Report, Harare, Zimbabwe. Pp 16. www.cimmyt.org/gis/rfseedsafrica/

Langyintuo, A.S. W. Mwangi, A.O. Diallo, J. MacRobert, J. Dixon, and M. Bänziger. 2008. An analysis of the bottlenecks affecting the production and deployment of maize seed in eastern and southern Africa. Harare, Zimbabwe, CIMMYT.

Machado, R. 1996. *Small business management series: marketing for a small business.* Kenwyn, South Africa: Juta and Co. Ltd.

MacMillan, J.G., Mudim, J.F. MacRobert, L. Rugube, E. Guveya, L.T. Mutemeri, and K. Chakanyuka, 1991. Ex ante B/C analysis of small farm maize research and demonstrations, Zimbabwe. Working Paper, Department of Agricultural Economics and Extension, Univ. of Zimbabwe, 2 August, 1991.

Maier, D.E. 1996. Ear corn drying, storage and handling fact sheet #29, Purdue University. http://www.ces.purdue.edu/extmedia/GQ/GQ-29.html

McCarter, S.B. 2002. Essential elements for a successful seed business. Presented at the Seed Production of Open-pollinated Maize Varieties Workshop, Harare, March 2002. CIMMYT.

McCarthy, E.J., and W.D. Perrault. 1990. *Basic marketing.* Irwin: Homewood.

Mkhari, J.J., M.R. Matlebjane, K.P. Dlomu, N.D. Mudua, and K. Mashingaidze. 2006. Case study of a community-based seed production scheme in two districts of the Limpopo Province, South Africa. In P.S. Setimela and P. Kosina (eds.), *Strategies for strengthening and scaling up community-based seed production.* Mexico: CIMMYT.

Monyo, E.S, M.A. Mgonja, and D.D. Rohrbach. 2004. New partnership to strengthen seed systems in Southern Africa. Innovative community/commercial seed supply models. In: P.S. Setimela, E.S. Monyo, and M. Bänziger (eds.), *Successful community-based seed production strategies.* Mexico, D.F.: CIMMYT.

Pixley, K.V., and M. Bänziger. 2004. Open-pollinated maize varieties: a backward step or valuable option for farmers? In D.K. Friesen and A.F.E. Palmer (eds.), *Integrated approaches to higher maize productivity in the new millennium: Proceedings of the 7th Eastern and Southern Africa regional maize conference.* 5–11 Feb. 2002. Nairobi, Kenya: CIMMYT (International Maize and Wheat Improvement Center) and KARI (Kenyan Agricultural Research Institute).

SADC Secretariat. 2008. *Technical agreements on harmonization of seed regulations in the SADC region: seed variety release; seed certification and quality assurance; quarantine and phytosanitary measures for seed.* Gabarone, Botswana: Southern African Development Community.

Scarborough, N.M., and T.W. Zimmerer. 1988. *Effective small business management.* Second edition. Merrill: Columbus.

Setimela P.S., Z. Chitalu, J. Jonazi, J.A. Mambo, D. Hodson, and M. Bänziger. 2005. Environmental classification of maize testing sites in the SADC region and its implication for collaborative maize breeding strategies in the subcontinent. *Euph*. 145: 123–32.

Steele, R.G.D., and J.H. Torrie. 1980. *Principles and procedures of statistics.* New York, NY: McGraw-Hill Book Company.

Steiner, G.A. 1979. *Strategic planning – what every manager must know.* New York, NY: The Free Press.

Tripp, R. 2001. *Seed provision and agricultural development.* London, UK; Overseas Development Institute (ODI).

UPOV (International Union for the Protection of New Varieties of Plants). 2002. General introduction to the examination of distinctness, uniformity and stability and the development of harmonized descriptions of new varieties of plants. Switzerland, Geneva.

Appendix 1.1 Example of a complaints form for receiving and handling complaints in a seed company.

Date Received: ...../...../.....	Complaint made by: Visit / Telephone Call / Other		Complaint Number:
Customer Nam Address:..... Tel No.:....			
Nature of Complaint:			
Product:	Variety:	Pack Size:	Label No.:
Place of Purchase:	Quantity Purchased:	Date of Purchase: ...../...../.....	
Storage Conditions:			
Planting : Method *(hand/machine)* soil conditions:			
Fertilizer applied: *(before and after planting)*			
Herbicide Used: Date of application...../...../.....	Application Rate:		
Weather: *(before and after planting)*			
Action Taken: *(stock replaced, agronomist visit, QC lab check on residual samples/ P & G Cert)* .... Date of action : ...../...../.....			
Results:			
Comment:			
Complaint Taken by (Name):		Date...../...../.....	
Copies to: Management, Quality Assurance, Research		Date: ...../...../.....	
Entered into Complaint Register by (Name):		Date:...../...../.....	
Cost of resolution:			

Appendix 1.2 Example of a complaints register for tracking number, type, resolution and cost of complaints.

Complaint Number	Date of Complaint	Nature of complaint	Seed Lot No.	Resolution	Cost of resolution

Appendix 2.1 Factors to consider when drafting contract specifications.

	General factors	Y	N
Responsibilities	The contract should outline the responsibilities and obligations of each party		
Enforcement	The manner in which the agreement can be enforced should be clarified		
Arbitration	The remedies that can be taken if the contract breaks down		
Legal requirements	Does the contract meet with the county's minimum legal requirements?		
Contract format	Will a simple registration format suffice?		
Understanding the contract	Are the farmers consulted in the drafting of the document? Is the language easily understood by the small-scale farmer? Should the contract be written in the local language or bilingual? Does the company employee explaining the contract understand the document? Is the farmer given sufficient time to review the document? Is the farmer given a copy of the contract document?		
Contract signatory			
Signatory	Is it important to monitor individual accountability and performance or will a group contract suffice?		
Contract specifications			
Contract duration	Would a short term or long term contract be more suitable?		
Quality standards	Has the number of grades been kept to a minimum? Does each grade should have a clear description of quality criteria that are easily understood?		
Production quotas	Does the quota match the company's ability to process, store or market the produce?		
	Is the farmer able to achieve the quota with the amount of input support?		
	Is the quota based on actual product volumes for the planted area?		
	Is the quota based on the level of company input support?		
	Is it possible to encourage farmers to increase productivity by giving higher prices when specified production targets have been obtained?		
Cultivation practices	Detailed specifications for cultivation practices should be made available to the farmer		
	All supplied inputs should be used in the correct quantities and farmers should follow recommended cultivation practices		
	No unauthorised agrochemicals should be used		
Crop delivery arrangements	Farmers should be informed of transportation arrangements		
Pricing arrangements	Farmers should be informed of the pricing structure		
	Prices should be related to grade specifications		
	Farmers should be informed of payment times and methods		
	Farmers should be allowed to verify weights of their produce		
Insurance arrangements	Companies might consider making insurance available to farmers		
Technical support	The contract should specify the extension support availed by the company including the duties of extension staff		
Management	Farmers should be informed of how the company intends to manage the contract		
Input support	Details of input support are usually presented as an attachment to the contract agreement		

Source: M. Dawes, 2008, personal communication.

Appendix 2.2 Example of a generic seed-grower contract.

MEMORANDUM OF AN AGREEMENT
made and entered into by and between

_____[Seed Company]_____

(hereinafter referred to as "the Company")

and

_____[Seed Producer]_____

of _____

(hereinafter referred to as "the Producer")

WHEREAS the Company is a specialist in the production of crop seed

AND WHEREAS the Producer is a farmer in the district of _____ (hereinafter referred to as "the farm") suitable for the production of seed

AND WHEREAS the Producer has agreed to produce EXCLUSIVELY for the Company on the farm, in the farming year commencing in _____ (hereinafter referred to as "the said year"), seed of crop _____ using parent seed provided by the Company

NOW THEREFORE THESE PRESENT WITNESSETH that the parties hereto have entered into and concluded the following agreement, that is to say:

1. The Company shall supply to the Producer free of charge _____ kg of _____ parent seed (hereinafter referred to as "the parent seed") per hectare for planting on _____ hectares of the farm. The seed shall be delivered to the Producer from the Company's factory by not later than the _____.
2. The parent seed shall be used solely for the purpose of producing seed of _____ for delivery to the Company and to this end the Producer shall:
   (a) plant the parent seed on the hecterage aforementioned not later than the _____, on properly prepared land on the farm at the seeding rate per hectare specified by the Company;
   (b) the producer shall regularly notify the Company before and during planting on the progress to avoid/reduce planting errors;
   (c) ensure that the land planted with the parent seed is a minimum of _____ meters distant from any other land planted to maize, that the land in question was not planted to the same crop in the previous planting year (save with the written approval of the Company) and that such land is fenced to protect it against animal damage;
   (d) ensure that the land used is properly managed in accordance with approved conservation methods and has adequate irrigation facilities to supplement the rainfall on the farm should this be inadequate and shall use such facilities as needed;
   (e) take all necessary steps for the proper fertilization and cultivation and harvesting of the crop grown from the parent seed (hereinafter referred to as "the seed crop") including the removal of all degenerate and off-type growth, in accordance with instructions received from the Company from time to time for which purposes the Producer shall retain an adequate labor force on the farm;
   (f) take all reasonable precautions against infestation by insects and pests, including the proper spraying of the crop with insecticides and fungicides as approved by the Company;
   (g) ensure that the seed crop is harvested and threshed as soon as possible after ripening, subject only to favourable weather conditions, and that special care is taken so as to ensure that none of the seed is damaged so as to impair it from germination;
   (h) take precautions against theft before and after harvesting including during processing;

(i) comply with any instructions given by the Company from time to time with regard to the production of the seed crop;
(j) comply with requirements laid down in the _____[National Seeds Regulations]____;
(k) ensure that all inspection reports required for the seed crop are timeously obtained and that the Producer complies with the requirements laid down in such reports;
(l) timeously notify the Company of any adverse occurrences that may have effects on the seed crop.

3. The Company shall be entitled through its duly authorized representatives to enter upon the farm at any reasonable time without notice for purposes of inspecting the land being prepared therefore, the production of the seed crop, storage sheds and other handling facilities. Such right shall also be enjoyed by Government appointed Inspectors. Inspectors' instructions shall strictly be adhered to.
4. (a) The Company shall pay to the Producer for seed crop produced by the Producer and delivered to the Company at minimum sum of USD_____/t.
   (b) Payment shall be made within _____ days from the date of delivery subject to compliance by the Producer with the provisions of this agreement and the seed complies with the required purity and germination standards.
5. Ownership of all germplasm (parent and seed crop) material remains the sole property of the Company. Any of the parent material not planted shall be returned by the Producer to the Company in good order on or before _____ _____.
6. The Company chooses domicilium citandi et executandi at _____, and the Producer at _____ _____. Any notice given by one party to the other or required to be given in terms hereof shall be in writing and may be left at or addressed and posted by registered post to the aforementioned addresses, and any notice so left or addressed and posted as above shall be deemed to have been properly given and received and in the case of a notice sent by post shall be deemed to have been delivered within seven days of the date of posting.
7. This agreement constitutes the entire contract between the parties and no variation shall be made thereto unless it be reduced to writing and signed by the parties hereto.
8. That should either party commit a breach of any of the terms and conditions of this agreement and fail to remedy the same within seven (7) days of the receipt of a written request so to do the other, non-defaulting party shall be entitled to cancel this agreement without prejudice to any claim which it may have for damages for breach of contract or otherwise and for the repayment of monies advanced. Upon the termination of this agreement the Company shall be entitled to require the Producer to destroy forthwith all the maize plants produced from parent seed supplied by the Company and the seed crop derived therefrom and should the Producer fail to do so, the Company is hereby irrevocably empowered through its agents or representatives to carry out such destruction.

THUS DONE AND SIGNED AT ..... ON THIS ..... DAY OF ..... IN THE PRESENCE OF THE UNDERSIGNED WITNESSES:

.....
for and on behalf of The Company

AS WITNESSES:
1.

2.

THUS DONE AND SIGNED AT ..... ON THIS ..... DAY OF ..... IN THE PRESENCE OF THE UNDERSIGNED WITNESSES:

.....
for and on behalf of The Producer

AS WITNESSES:
1.

2.

CIMMYT

International Maize and Wheat Improvement Center
Zimbabwe: P. O. Box MP163, Mt Pleasant, Harare, Zimbabwe
Mexico: Apdo. Postal 6-641, 06600 Mexico, D.F., MEXICO