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The impact of HIV/AIDS on mining in Africa: a Botswana case study

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Botswana has undergone rapid socio-economic development since independence, principally due to the sound management of mining sector revenues. All these advances are in the process of being reversed by HIV/AIDS, which will affect 19% of the population by end-2000. Sero-positivity amongst mineworkers exceeds 30%. A quantitative model is used to forecast the development of the pandemic over the next 30 years. Indications are that the workforce age profile will begin to alter radically within 5 years. In 5-15 years, recruitment systems will be placed under severe pressure and mines will experience a potentially critical loss of skills. A five-year window of opportunity is available during which to put into place management strategies that deal with the impact of HIV/AIDS, including: comprehensive testing, treatment of STDs, condom distribution and the immediate expansion of recruitment and training activities. Failure to do so may compromise the ability to exploit some of Africa's premier mineral deposits.

Introduction

Botswana is a sparsely populated (estimate 1.5M) Southern African Development Community member state. Since independence in 1966, Botswana has emerged as the World's largest diamond producer by value, with output likely to exceed 25 Mct in 2000. Mining has driven one of the highest economic growth rates in the World (21.7% average annual growth from 1975 to 1995). In 1995, mining accounted for 32.1% of GDP and 76.3% of exports, 93% of which were attributable to diamonds. Mining is likely to contribute >60% of government revenues for the next decade (MFDP, 1996).

Sound economic management and uninterrupted political stability have resulted in steady socio-economic and infrastructure development. Botswana also had, prior to HIV/AIDS, one of Africa's highest life expectancies (62 years in 1985-90) and population growth rates (3.5%). This has been accompanied by rapid urbanisation, ease of travel on a high quality road-network and a young population profile with 29% aged below 15 years and 45% aged between 15 and 49 years (CSO, 1991). Human capital development is prioritised by government, both to empower citizens and to support economic diversification through the availability of a skilled workforce. Consequently, education is the largest recipient of government's development and recurrent expenditure (17.1% and 29.1%, respectively).

Since 1992, annual HIV surveillance has been conducted amongst the 95% of women who attend antenatal care (CSO, 1998). Projections based on these surveys indicate that 19% of the population will be living with HIV by the end of 2000 (Ministry of Health, 1998). Sero-positivity amongst pregnant women exceeds 40% in the main urban centres. Mines who have conducted HIV surveillance record sero-positivity of 30-35%. Sub-Saharan Africa in general and Botswana in particular have the World's highest HIV/AIDS prevalence rates (UNAIDS, 1999). The combination of a mining dependent economy and high HIV/AIDS prevalence makes AIDS-impact management in the mining sector a matter of national importance.

This paper begins by forecasting the impact of HIV/AIDS on a typical mining workforce under different scenarios. It then goes on to analyse the implications of HIV/AIDS for the mining sector before reviewing both general impacts and specific issues emerging from model: in particular, for recruitment and the maintenance of operational skills. The

conclusions present strategies for addressing these challenges, especially during the critical period during which the full impact of AIDS-mortalities is becoming established and before such time as public health initiatives are able to mitigate HIV/AIDS effectively.

HIV/AIDS impact forecasting

This section uses a simple model to evaluate the broad implications of HIV/AIDS on mines by quantifying the impact of AIDS-mortalities on the workforce. A thorough analysis would require detailed health statistics, social and epidemiological characteristics to be subjected to sensitivity analysis, which was beyond the scope of this paper.

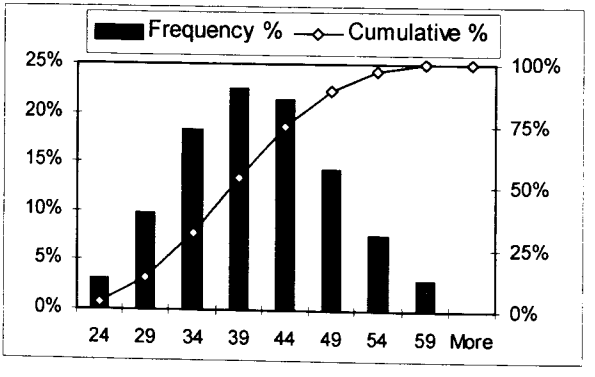

Figure 1: Age distribution July 2000 (n = 197)

The initial population The initial age distribution data-set used by the model was obtained in July 2000 from the production section of one of Botswana's mining operations (**Figure 1**). The distribution's relatively high mean age of 38 years 8 months (□ = 8 years 1 month), stems from a number of factors:

- Major mining operations in Botswana are less than 25 years old, so current retirement rates are low (<1% in this sample)
- Unemployment is high (21%; Seloilwe, 2000) and alternative jobs are scarce, reducing the incentive for employees to move
- Recent downsizing exercises have encouraged the redeployment of existing staff rather than the recruitment of new blood

Model assumptions The initial workforce age distribution was projected in five-year increments over 30 years from today subject to:

- All staff retiring at age 60
- No resignations or non-AIDS related mortality
- Workforce size remaining constant
- All new employees being aged 20-24 years (mean 22.5) and HIV-negative
- HIV prevalence remaining constant throughout the population during the model period
- AIDS-related mortality occurring in fixed proportions after 5, 10, 15 and 20 years
- Life expectancy at the beginning of the model period being calculated conservatively by assuming no HIV-prevalence predating year 0.

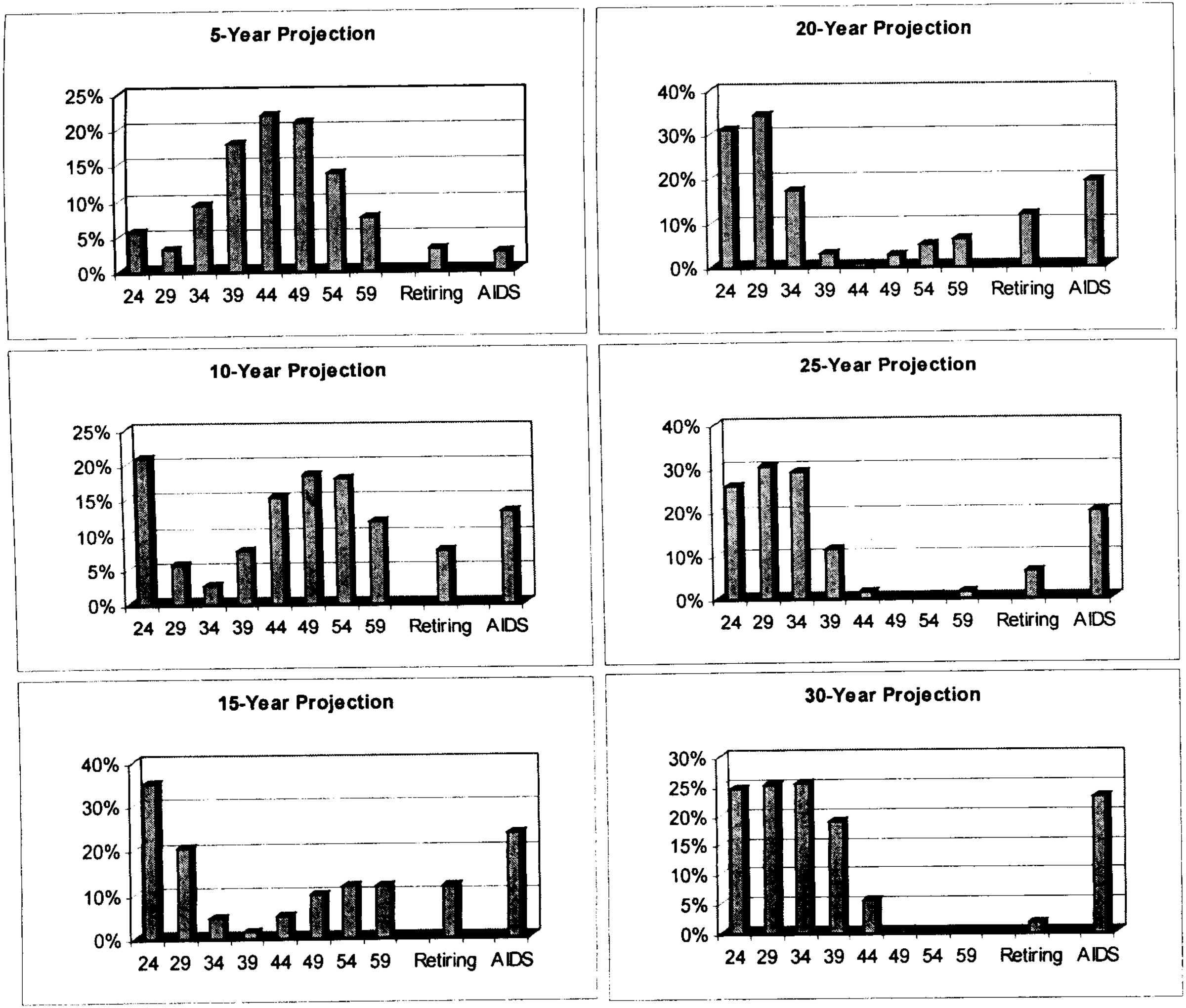

Figure 2: Evolution of best case age-distribution, retirement and AIDS-mortality related over the period 2000-2030 (projections are cumulative over 5 year periods ending at the projection year from present, e.g. 25 year projection is equivalent to 2020-2025)

These conditions are assumed to provide a realistic basis for conservative estimation, even though several additional variables exist, such as: changes to risk-averse behaviour over time, age and gender related infection rates, the impact of secondary infections, sickness-related absenteeism, etc. For example, indications from mines in Botswana are that absenteeism has risen ten-fold in the past 5 years to an average of 3-4% of total available person-shifts, which would reinforce the effect of AIDS-mortalities.

Base case model results **Figure 2** shows the cumulative results for 5-year periods from 2000-2030, based on the current sectoral HIV prevalence of 30%. Mortality is assumed to reach 10%, 50% and 100% after 5, 10 and 15 years respectively, which is equivalent to an average post infection life expectancy of 12 years.

The 5-year projection for 2000-2005 closely reflects today's age distribution incremented by 5 years. Cumulative staff turnover, as indicated by the 20-24 year category, is only 5.6% in 5 years or around 1% per annum. Consequently, this period is characterised by a negligible recruitment requirement. AIDS-mortality is likely to be a less significant factor than retirement or deaths due to other causes, e.g. car accidents. Operational units with less than 40 staff may not experience any AIDS-related deaths.

It is during the subsequent 5-year period, from 2005-2010, that AIDS begins to impact significantly. A strongly bi-modal age distribution of new recruits and older employees emerges and persists over the following decade.

Over the period 2000-2010, some 15.8% (one in 6) of the workforce is expected to die because of AIDS, with an additional 10.7% retiring. Replacing a quarter of the workforce over one decade should be within the capability of existing mine HR systems. However, the non-linear impact of AIDS is likely to mean that recruitment requirements towards 2010 may significantly exceed the 4.2%, or one in 24, annual average for the period. AIDS-deaths are likely to affect around 1 in 7-8 positions between 2005 and 2010.

By 2010-2015, the workforce age distribution will have radically altered. Projected staff turnover reaches 35.2%. This means that less than two thirds of the workforce will have more than 2.5 years of experience. AIDS-related deaths will affect one in four positions during this five-year period. The loss of overall experience coupled with the significant potential for mortalities at supervisory and management levels, indicates the very real possibility of major skills shortages in key areas affecting productivity and operational viability.

The 20-25 year projections, covering the period 2015-2025, show AIDS-related deaths stabilising at around 3.9%, or 1 in 25, per annum. Retirements, which are purely a function of the present day age distribution, also peak during this period. This in turn leads to high annual recruitment levels of 5.2-6.2%, or one in 16-19, being required for a decade.

By 2025-2030, the long-term age distribution is established. This is characterised by a skewed, truncated pattern whose mean and variance depend primarily on AIDS mortality characteristics. Retirement is of negligible importance as few workers survive to 60. For comparison, current life expectancy in Botswana is 47 (UNAIDS, 2000). It takes the model a further 5-10 years, i.e. 35-40 years from now, before AIDS mortalities and recruitment levels begin to stabilise at around 28% every five years, or 5.6% (one in 18) per annum.

HIV/AIDS impact on recruitment and experience The model expresses AIDS-impact through the need to fill vacancies due to mortalities, which is a recruitment issue. Another consequence is the change in the workforce's age distribution. This can be approximated by average ages, which indirectly correlate with the operational skills base of the organisation, its 'human capital' (**Figure 3**).

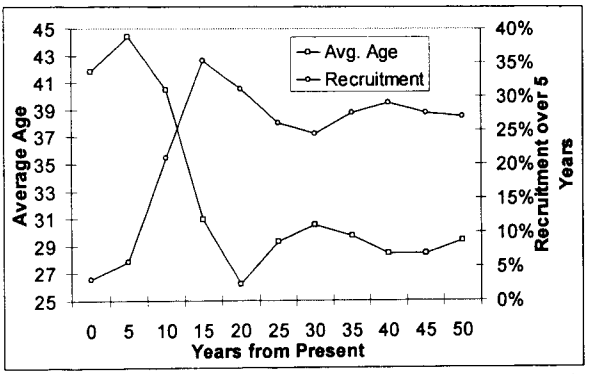

Figure 3: Base case model long term trends in average ages and 5-year cumulative recruitment.

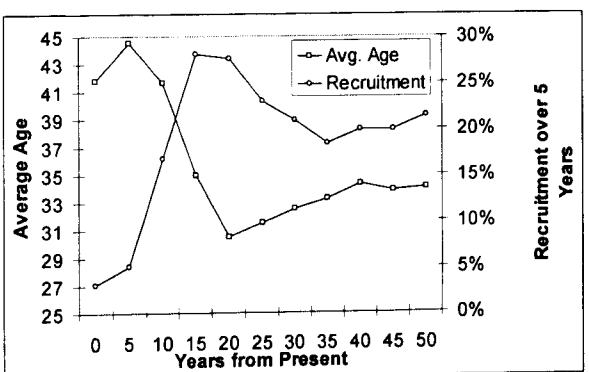

Figure 4: Scenario 1 long-term trends for HIV-prevalence reduction from 30% to 20%.

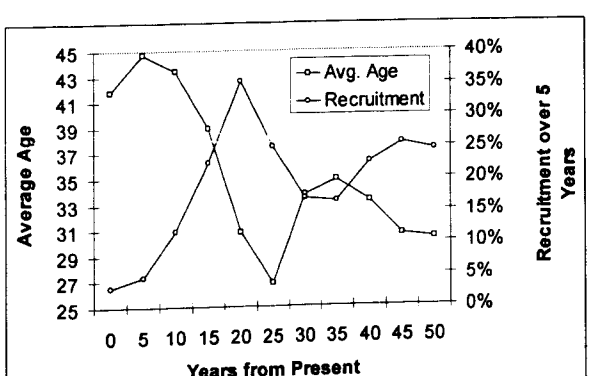

Figure 5: Scenario 2 long-term trends for increase in life expectancy from 12 to 17 years.

These two parameters behave in a complimentary manner: average age falling as recruitment rates rise. For the base case, recruitment rates increase 5-fold over the period 2005-2015, peaking at ten times current levels before stabilising at a turnover of 25-30% every 5 years. After remaining artificially high, because of low retirement rates, average age plummets over the period 2010-2020 reaching a low of 26 years, or only 44 months of work experience, before stabilising in the range 28-30 years (average 7 years work experience).

The timing of these shifts reflects the assumed average AIDS life expectancy of 12 years. As the model does not make any assumptions about employees who are HIV-positive prior to year zero, i.e. 2000, these shifts are actually likely to occur earlier.

Alternative scenarios The simplicity of the model limits its use as a tool for analysing complex scenarios, but two basic ones are discussed:

Scenario 1: The consequences of reduced HIV prevalence, e.g. through systematic behavioural changes
Scenario 2: The consequences of increased life expectancies, e.g. through the use of medical treatment

Figure 4 shows average age and recruitment trends for Scenario 1, where HIV-prevalence is reduced from 30% to 20%. Although the patterns are broadly similar to the base case model, the peak and average age trough are less pronounced. Recruitment per 5-year period peaks around 28% from 2010-2020, compared to 35.2% in the base case, and stabilises around 20% compared to 27%. Average ages fall to 30.5 years in 2015-2020, equivalent to approximately 8 years of work experience, climbing by 1-2 months per annum thereafter.

Figure 5 illustrates Scenario 2, where life expectancy is increased from the base case's 12 to 17 years, whilst maintaining 30% HIV prevalence. This is achieved by altering the mortality distribution to 5%, 15%, 40% and 100% after 5, 10, 15 and 20 years respectively.

Apart from offsetting the recruitment peak and average age trough by 5 years as anticipated, the patterns are notably more oscillatory. With the exception of the period from 2015-2020 when it peaks at 35.2%, recruitment averages at 4-5% per annum. Although average ages generally remain higher, in the range 30-35 years, there is still a significant minimum of 27 years (52 months average work experience) during the period 2020-2025.

Summary of model results Starting from the present day, the following emerge as significant trends, patterns and events:

- The initial age distribution found in mines results in low retirement rates for the next 5 years
- Retirements will be more or less eliminated by AIDS-mortalities within 30 years
- Annual AIDS-mortalities will affect approximately one in 200 staff over the next 5 years, rising to one in 40 by 10 years and remaining between one in 20-25 thereafter
- Recruitment levels will increase sharply over the coming 10-15 years and may peak above 7% of the workforce per annum before stabilising around 5-6%.
- Over the next 30 years, the age distribution of the workforce will undergo a major transition: from today's normal distribution with 90% of ages between 25 and 55 years about a mean and mode of 40 years, to 90% of ages between 20 and 45 with a mean of 30 and a mode of 25.

- Between 10 and 30 years from now, the age distribution will be strongly bimodal, with increasing numbers of young and decreasing numbers of older employees. During this period, the effective average age is likely to be even lower due to the biasing effect of the progressively aging 'older' portion of the population. Loss of experience is consequently expected to be, if anything, worse than expected.
- The base case and scenarios show at least a 5 year period during which recruitment peaks and average ages slump, potentially to unsustainable levels, before these parameters stabilise.

Implications of HIV/AIDS on African mining

Much has been written about the broader implications of HIV/AIDS and readers are referred to the website of UNAIDS <http://www.unaids.org/> as an excellent source of literature and statistics. General issues are only dealt with briefly and the main discussion will focus on specific consequences of the previously presented model.

General impacts Two of the principal concerns at national level are the reversal in economic gains and the reduction in life expectancy that result from HIV/AIDS. Having reached 62 years in 1985-1990, the highest in Africa at the time, life expectancy in Botswana had by 1998 fallen to 47 (UNAIDS, 2000).

Of direct concern to the mining sector is the increase in opportunistic infections that is symptomatic of high and growing HIV/AIDS morbidity. Hospital costs can represent a significant proportion of production costs, particularly where employers endeavour to provide high standards of health care or where they fulfil a community health-care role. Over the next 5 years, it is anticipated that bed-occupancy rates will approach and exceed 100% due to high readmission rates. Treatment costs will also escalate, with obvious consequences for overall costs.

Providing care for people living with AIDS (PLWA) and orphans will inevitably prove to be beyond the resources available to Health Ministries in developing countries. Regardless of government initiatives, it is clear that the burden of care will increasingly fall onto those in employment. Household earnings are likely to be reduced, whilst expenditures increase, resulting in a trend to greater deficits and financial hardship. Although mining is usually not the largest employment sector, it generally provides a relatively reliable source of income for its workforce. Mine employees will inevitably become key players in providing support to extended family members affected by HIV/AIDS.

Projected single digit growth rates in developing countries national products are insufficient to provide the additional revenues that governments will require to meet the greater health and education expenditures resulting from HIV/AIDS in the coming decades. It can be anticipated that important foreign currency earners, such as mining operations, will see increases in direct and indirect taxation as a result.

Human capital impacts The primary features of the model are the antithetic trends of recruitment and average age. Once prevalence reaches the levels of 20-30%, as is the case in sub-Saharan Africa, HIV/AIDS imposes such a dramatic cap on the life expectancy that it becomes extremely difficult to maintain skills within the workforce' particularly if these take more than 5 years to acquire. Although the model does not consider the possibility of recruiting experienced people to fill vacancies, the pandemic is so widespread that it will affect the entire pool of potentially eligible employees.

Unless measures are taken to directly address life expectancy in infected populations through medical intervention, the base case and scenarios suggest that no more than 5 years from today, i.e. by 2005, recruitment requirements will begin to rise dramatically.

Indications are that the proportion of AIDS-mortalities will rise to one in 20-25, or more, per annum. Operations or sections featuring high levels of specialist or supervisory skills, e.g. technology-rich, mechanised or large mines; maintenance, engineering and technical sections; or mineral processing plants, will increasingly struggle to maintain core competencies.

The sexual behaviour of individuals in senior management positions is a major issue. If prevalence within this group is comparable with the average, commensurate levels of mortality will impact directly on organisational planning and management capabilities. These are areas in which skills take perhaps a decade or more to be developed and are difficult to replace.

Policy impacts Although critical to the well being of mining operations, HIV/AIDS containment policy is a specialist area that is outside of the scope of this discussion. Nevertheless, it is appropriate to highlight some of the more significant issues that stakeholders, i.e. government regulators, unions and employers, need to address.

Perhaps the most controversial of these is the issue of HIV testing and confidentiality. Although discrimination because of infection is not to be encouraged, it is important to recognise that the viability of some operations may be compromised, particularly at high prevalence rates. Similarly, employees requiring lengthy preparatory training need to be able to complete this and apply the acquired skills in order to add value in the workplace. Large-scale anonymous testing is therefore an essential prerequisite for robust planning, with implications for the design of health programmes, training and staff development, recruitment and the early detection and treatment of opportunistic infections.

HIV/AIDS considerations need to be incorporated into benefit policies, not only because of its effect on life expectancy and the chronic nature of infection, but because of the need to determine what sort of financial assistance should be made available to infected staff or those responsible for PLWA.

Finally, there is the vital importance of ensuring safety against work-place injuries.

Managing HIV/AIDS impact at the mine level

Despite considerable investments in awareness programmes, none have achieved the desired result of positively altering high-risk behavioural patterns. Surveys conducted at the University of Botswana indicate that the most effective tool in providing awareness is the radio, which has four times more impact than work-based education schemes. Unfortunately in Botswana, knowledge, regardless of its origin, does not appear to influence social behaviour significantly (Seloilwe, 2000). Although it is critical not to abandon these efforts, it is evident that most organisations have yet to design AIDS-education strategies that effectively communicate with their target groups.

The two most effective measures in controlling HIV/AIDS are the treatment of STDs and the aggressive promotion of condom distribution. Other practical steps that all organisations should take include:

- Incorporating HIV/AIDS record keeping and monitoring into systems of medium to long-term mine planning
- Co-ordinating HIV/AIDS activities, especially with planning and HR

At this stage, it is necessary to acknowledge that stakeholders must seek to actively manage the situation and not rely on being able to change social behaviour.

Managing recruitment The position in which mines currently find themselves is challenging. Intensive efforts to effect behavioural changes in employees are still to yield results, yet despite dire warnings AIDS-mortalities are not significant, although absenteeism arguably is becoming so. Simultaneously, efforts to improve productivity combined with the erosion of competitiveness due to global market forces, have established conditions under which sometimes substantial downsizing of workforces is taking place. Recruitment is simply not a priority. The risk is that this situation will be assumed to remain constant, whereas the model shows that staff turnover will change quite suddenly and in an ever-accelerating fashion 5-15 years from now.

The recruitment and subsequent staff development process is the most direct way in which employers can control the makeup of their workforces, but this is a long-term process. In production environments, where work experience is a critical element, a significant proportion of the training is commonly conducted on the job under formal and informal mentoring arrangements. Consequently, there will be limits on the capability of any organisation to absorb and develop new staff.

Logically, most organisations are capable of turning over their workforce within the average period of employment. For example, mines should be able to replace 3-4% of the workforce annually, which is equivalent to saying that the average worker is in employment for 25-30 years. By comparison, the model indicates that annual recruitment requirements could exceed 7%. Whether this is sustainable depends on the point at which accommodating recruits becomes an unacceptable cost, e.g. through its impact on productivity. This will vary between mines and within sections, but is clearly a parameter that needs to be determined.

Future peak recruitment requirements can be offset by increasing presentday recruitment; creating a staff surplus that can be offset against future needs. Maintaining a consistent level of recruitment has the advantage of enabling appropriate recruitment systems to be established and maintained, with the expectation that these would be more cost effective than situations where recruitment targets are changing radically over short time-scales. The recruitment requirements of the model over the next 20 years are equivalent to a constant annual turnover of 4-5%. This rate would address, but still not meet, long-term requirements if AIDS continues on its present course, unless life expectancies can be increased and/or prevalence rates reduced. In the short-term, such a policy would increase the workforce by 15-20%, although this figure would be mitigated by the already high and still increasing rates of absenteeism.

To further evaluate this argument it would be necessary to analyse the potential impact of the peak in recruitment requirements that is expected in 10-15 years time and, more specifically, the potential implications on profitability of being unable to meet this need for new employees. A potential advantage of initiating a positive recruitment policy now, is that the pool of potential employees is still large. In future, it will become increasingly difficult for employers to be selective as more players are forced to address AIDS-impact.

One of the most significant features of the model is the dramatic, albeit short-lived, collapse in the average age of the workforce. This can be countered by selectively recruiting individuals with appropriate amounts of experience who are specifically earmarked to fill the anticipated gap in the 30-40 year group. This group, which currently provides the bulk of mines' experiential human resource reserves, is precisely the one that projections indicate will be decimated by AIDS in the medium term.

Before moving on, it is worth revisiting the issue of routine testing. If excess compliment is maintained on short-term contracts, this allows for legitimate testing as part of the contract renewal process. Politically, testing issues could be mitigated by the provision of additional employment.

Managing training and development Many developing countries are prioritising investments in education, with the result that the available pool of talent is steadily increasing. Higher employee turnovers therefore offer companies a real opportunity to develop a more skilled and flexible workforce, which is better able to adapt to changing technologies and work practices.

AIDS' impact on skills will be two-fold. Firstly, will be the need to rapidly incorporate new staff into the workforce. Secondly, and more critically, is the necessity to cover essential technical and supervisory skills that traditionally take time to develop. Currently, most mine training is reactive, aiming primarily at providing essential skills or filling anticipated vacancies. However, once annual turnovers reach 5-7% different strategies will be needed. Experienced front-line supervisors and skilled artisans, who generally need to be available locally, are likely to be the most difficult group to replace; and acute shortages at this level could potentially threaten operations.

In Botswana, a collaborative technical training venture involving government and the mining sector was launched in 1994. Specifically aimed at preparing operators to move into supervisory positions, it allowed the identification of three factors that significantly impact on the potential success of training and development programmes: accessibility, motivational strategies and integration.

Many educational institutions are adopting modular life-long learning frameworks. These are intrinsically flexible, in terms of both their structure and their mode of delivery, which can be by full-time and part-time study, distance or web-based education. Access to learning opportunities and easy integration of training into the workplace is facilitated as a result. Furthermore, where training systems operate within a national qualifications framework, the ability to obtain recognisable and transferable qualifications becomes a powerful motivational factor encouraging individuals to actively participate.

In terms of learning content, mines need to adopt a less rigid attitude. It is important to acknowledge that environments in which multi-skilling is important require learners to have broad background skills, opportunities to quickly and effectively acquire new skills and an incentive to develop skills that are not necessarily required immediately, but may be in future.

Currently, training is often compromised in favour of production targets, particularly where it is not seen to be essential or where it cannot deliver measurable short-term benefits. However, the previous section's arguments for increasing workforces over the next decade would provide the necessary flexibility, because of overstaffing, to allow the proportions of training time to be increased. An advantage of this approach would be that skill levels could be substantially increased, providing a buffer against the anticipated loss of competencies 10-20 years from now.

Conclusions

The features of the model have already been summarised, but it is worth reiterating the following critical points:

The principal impact of HIV/AIDS will be on staff turnover and the amount of experience available within the workforce, both will reach levels where totally new approaches will be required

The composition of mine workforces in the future will be significantly different from today, younger, less experienced and increasingly volatile

Mines will come under ever-greater pressure to support nations suffering abnormally high AIDS-impacts. Both indirectly through providing the salaries of staff who are the focus of support networks, and as corporations that are vital sources of foreign exchange.

Instead of focussing on AIDS initiatives aimed at encouraging behavioural changes, mines must concentrate on strategies for dealing with the consequences of AIDS. Unless massive investments are made in medical treatment, no more than 5 years are available to implement these strategies.

Comprehensive, anonymous testing must be introduced as soon as possible to provide accurate data that will allow effective planning. This should be coupled with intensive efforts to treat STDs and distribute condoms, as the two currently

Recruitment should be stepped up immediately (a rule of thumb being to recruit 1.5% of workforce per 10% of present day HIV-prevalence), with the aim of creating a buffer against the rapid increases in AIDS-mortality and AIDS-related absenteeism that are anticipated 5-15 years from now.

Training programmes should be incorporated into this recruitment policy in order to target those skills, currently residing primarily in the 30-40 year age group.

Perhaps the greatest potential threat to Africa's mining industry is the loss of competitiveness that may result from AIDS. A position is being faced where a strategic sector is being threatened by completely new forces, which are quite capable of making World-class deposits unexploitable and increasing the risk associated with mineral resource development on the African continent.

Notes

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