An overview of sugar culture in Morocco, particularly within a Berber community in Rastabouda

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Abstract

Using an anthropological perspective and referring primarily to work by Sidney Mintz, Michel Foucault and Pierre Bourdieu this dissertation focuses on the cultural importance of sugar in rural Berber communities within the Rif region of North Africa. In particular, Mintz is referred to with regard to slavery, Bourdieu in relation to habitus and Foucault in relation to normalization of mass beliefs as well as to events occurring in Morocco which relate directly to power structures within society. As well as providing information about the cultural importance of sugar, an historical account of the development of the sugar industry in Morocco is provided. This includes subsequent economic effects both in Morocco and Europe, with details in relation to the development and decline of the sugar industry, the introduction of slavery to Morocco as well as worldwide economic influences. The latter also demonstrates that sugar has been attributed power which is exerted not only within Berber culture from birth to death, but has had an influence throughout social and economic history since the introduction of the Qu'ran to the present day. An argument is developed which suggests that the presence of apparent discrimination and inequalities have arisen partly from a pure desire for sugar. Some long lasting health and environmental effects of processing sugar are outlined and discussed in relation to the health of Rif Berber. This includes a general outline of societal inequalities between genders in health care, including diseases such as diabetes. Tuberculosis along with diabetes, are discussed in order to show that they are social markers which reinforce various power structures within Moroccan communities. The emergence of

slavery, land use, and the effects of the rise and subsequent decline of the sugar industry in Morocco are covered. Examples are given of how power shifted from those initially in authority to individuals at local level who complied with certain social norms and beliefs. This closely relates to the importance of sugar in Morocco, its relevance as an introduced crop along with the subsequent social, national and international changes which occurred and to a large extent remain firmly in place today. The long-lasting environmental impacts of the sugar industry represent both direct and indirect power struggles which are unlikely to be remedied without international intervention.

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Acknowledgements

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Figures

1. Introduction

This dissertation presents eight main sections. The first is an overall introduction to anthropological theory, and an introduction to global sugar production and the science of sugar. Anthropological theories include the subject of power as presented by Sidney Mintz, social analysis as presented by Pierre Bourdieu and social structure as held in place within society by religious and cultural beliefs, as presented by Michael Foucalt. The second explains the significance of sugar within Berber society. This shows the traditional and cultural importance that sugar plays in festivals and daily life, providing an overall insight into the general nature of sugar and its importance within both the cultural and traditional aspects of Berber life. A link between sugar and gender, family, and community power structures within Berber society are drawn together. The third provides an historical overview of the sugar industry in Morocco which covers the period 500 AD to the present time. Diabetes and tuberculosis are covered in section four. The roles that sugar plays in maintaining habitus and order, where habitus relates to an individual's predisposition in relation to the presence of societal norms, values and beliefs including cultural and faith systems are provided throughout these intial sections.

Growing and harvesting sugar cane is introduced in section five and includes issues relevant to the environment, such as blanket fertilisation and contamination of ground water and soil. This section also outlines health effects in relation to harvesting techniques. This also includes a discussion in regard to the methods of processing and refining sugar cane using mills. Issues associated with leachate and by-products which

end up in the environment and are subsequently passed on to humans in contaminated food are discussed. Section six addresses the problem of specific by-products, such as molasses, bagasse and fibre and possible remediation techniques. A discussion then outlines existing issues today, and includes an overview of sugar's place in Morocco today. The final eighth section provides a concise conclusion followed by potential future research topics of interest.

1.1 Introducing the theories of Sidney Mintz, Pierre Bourdieu and Michael Foucault

Sidney Mintz is an anthropologist who has published works in relation to peasantry, slavery, and exploitation in regard to the sugar cane industry (Mintz, 1959a, 1960, 1978, 1985a, 1985b, 1996a). He has also completed research on the history and meaning of food (Mintz, 1978). Of particular interest are his works on sugar plantations in the Caribbean (Mintz, 1959a), slavery (Mintz, 1978), his social-cultural analysis of a sugar cane producing village in Puerto Rico (Mintz, 1966), and study of an individual sugar cane worker, also in Puerto Rico (Mintz, 1959b, Mintz, 1960, Mintz, 2002). Further studies of interest include the effects of sugar plantations in the Caribbean in relation to consumer behaviour in Europe and the world economy (Mintz, 1985b, 1985c, 1996a). His later works focus on the history of sugar worldwide (Mintz, 1985a), eating, culture and the past. Mintz (2005) believes that explaining the importance of food in its symbolic form allows communication and revelation about individual and group identities.

Bourdieu's work has had a major influence in the areas of sociology, anthropology, education, and cultural studies. His work "Distinction: A Social Critique of the Judgment of Taste" (Bourdieu, 1984) is considered a significant contribution to Sociology by the International Sociological Association (2007), and his work "Outline of a Theory of Practice" (Bourdieu, 1977) is one of the most cited books on this topic in the world (International Sociological Association, 2007; Bourdieu, 1977). His work has also influenced history, literature and aesthetics (Bourdieu, 1996).

Bourdieu believed that society cannot be analysed by looking at one factor alone, such as economic class or ideologies, but rather, other factors such as education and culture need to be incorporated into social analysis (Bourdieu and Passeron, 1990a). He uses the concept of 'field', in that there is a social arena in which people manoeuvre and struggle in pursuit of desirable resources. A field is represented by a system of social positions and is directly structured in terms of power relationships, and represents the struggle to ascertain capital gain, of which the most common struggle is related to monetary gain (Bourdieu and Passeron, 1990). Fields are present within society, such as community and family, and are often autonomous independent forms of social play which are not necessarily limited to monetary gain, but relate to cultural and symbolic as well as to capital gain (Bourdieu, 2005). Fields can be complex and inter-related (Ward, 2004). He also argues that the social world functions simultaneously as a system of power relations and as a symbolic system in which even minute distinctions of taste become the basis for social judgement (Bourdieu, 1984).

Foucault was a philosopher and historian whose work also spanned many disciplines and included the history of sexuality and power within relationships (Todd, 1955;

Foucault, 1978). He described power as "a complex strategic situation in a given society", which is held in place by strongly held beliefs in relation to structures present in society, which lead to both constraint and enablement (Todd, 1955). Foucault explained how power exhibits various forms of constraint on the actions of individuals, communities and society, but how it also makes certain actions possible, although these may be limited (Foucault, 1979).

The theories of Mintz, Bourdieu and Foucault focus on mass compliance in relation to accepted norms and values in society. They argue that it is widely accepted norms and values within society and communities that exert power, control and compliance of the population to which mass religious beliefs also contribute. In Morocco it appears that power is exerted at all levels via religious beliefs and cultural traditions which results in conformity within the mass population. In addition to social power, there is power exerted by authorities both nationally and internationally but probably the most important to mention is that of the unseen ultimate power, Allah, although in Berber communities' superstition and folk law appear to be given more emphasis.

1.2 An introduction to Berber people and their language

The hilly coastal region of north-eastern Morocco is referred to as the Rif and is also known as El-Rif (Rif, 2007) (Figure 1). Contrary to popular belief, North African countries are not Arab nations, but Berber nations, who speak a different language than the introduced Arabic language. Berber is a European word used to describe the people and languages spoken by Berber communities. The Berber people call their

language Amazigh and often refer to themselves as Rif, although Rif also refers to the area of interest. In the Rif region of Morocco, Berbers speak one of the three Berber languages; Tamazight, Tashahit or Tarifit. The Amazigh language, known as Tamazight is spoken by approximately one-third of the people, and has been preserved in Amazigh enclaves. Tamazight is recognised as the root language of many of the Berber dialects and uses a neo-tafinagh alphabet (Khalaf, 1996) (see Appendix A).

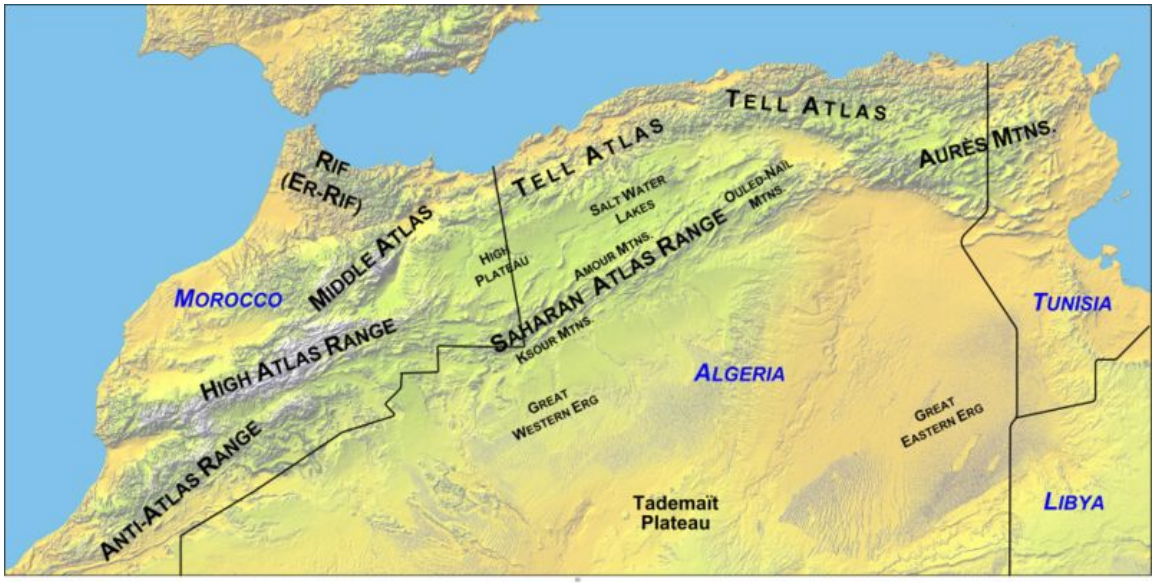

Figure 1. Outline of Morocco showing the regions Rif, Middle, High and Anti-Atlas.

The specific area of interest, and one I have visited on twelve separate occasions, has a large population of elderly people over the age of 60 years old. Other mature Berber people, who reside in Rastabouda, that is, those between the ages of 30 and 60 years old, generally do not read or write and many of them do not speak any other language but Berber. As a result written records are not maintained. Traditional folk law is communicated verbally from one generation to another. Dialects between villages may also differ, and one dialect is not necessarily understood by a neighbouring

village who may speak a different dialect. These factors present complex issues in regard to education, gaining medical assistance or informing communities about health and environmental issues.

It is important to have a general overview of life in Morocco so any problems and issues faced may be viewed in perspective. Morocco is a poor country and many rural villagers live in abject poverty. This results in a lack of opportunity in regard to schooling their children. Although schooling is reported to be freely available to all children born in Morocco, in reality school supplies, clothes and poor hygiene prevent many children from attending (M'Jid, 2003; Uddin, 2006). When children do have an opportunity to attend school, teachers are often unwillingly assigned to a particular area and are therefore unmotivated and unhelpful (M'Jid, 2003).

The overall socio-economic factors in Morocco, as a result of the presence of poverty, include weak or no social security leading to extreme poverty, large families, unemployment, illiteracy, lack of educational opportunity, economic exploitation of children in using them to solicit sympathy by begging on the street and forcing them into child labour and sexual slavery, as well a lack of community spirit and social solidarity (Burgess and Draper, 1989; M'Jid, 2003: Wadoux, 2005). The psycho-affective factors include a lack of affection and abuse where there is often a lack of meaningful conversation resulting in social exclusion (M'Jid, 2003; Uddin, 2006). What is meaningful in all social classes and at all levels within Moroccan communities is the desire for sugar.

Sugar represents a social leveller, in that it is sought by all members of Moroccan society, whether the King, or an illiterate villager living in poverty. Whatever the social status or educational status of an individual in Morocco, sugar is equally revered and sought.

1.3 An introduction to sugar and the world's sugar producers

Sugar cane (*Saccharum officinarum*) was first described by Linnaeus in 1753 (Reveal and Terrell, 1989) and is in the family Gramineae (Reveal and Terrell, 1989). The largest sugar cane producers in the world include Brazil, Cuba, Kazakhastan, Mexico, India and Australia, although it is also grown in many more countries including Puerto Rico, America and Hawaii (Brown, 2002).

In 2000, world sugar production, from all different sources, amounted to 12 million tonnes. Consumption was 8 kg per capita, (Almazan *et al.,* 1998). Currently the worldwide demand for sugar exceeds the ability to supply it (Escalona, 1952; Lorenzo and Gonzalez, 1998). It is estimated that by the end of this century sugar production will have grown ten-fold and per capita consumption three-fold (Almazan *et al.,* 1998). Even with the appearance of new sweeteners on the market, sugar is still the most widely used caloric food in all countries, especially among lower socio-economic classes (Almazan *et al.,* 1998). In many poor countries the sugar industry is the main source of employment. In particular, the sugar industry creates many jobs in

underprivileged countries (Escalona, 1952). This is especially the case throughout the Americas (Escalona, 1952), in particular, Central America and South America, including, Brazil (Basanta *et al.,* 2003), and the Caribbean (Thomas, 1997; Brown, 2002), Mauritius (Lichts, 2005), Pakistan (Rouilland, 1990), Cuba (Gersper *et al.,* 1993), Kenya (Ouma-Onyango, 1997), India (Government of India, 2005) and Thailand (Cheeseman, 2004), as well as in more affluent countries such as Canada (Graf *et al.,* 1996) and Australia (Meyers *et al.,* 2005) and the Everglades in the United States (Coale *et al.,* 1994a),

Brazil is the world's largest sugarcane producer with a cultivated area of about 5 million hectares (Basanta *et al.,* 2003). Sugar also covers more than 49% of the island of Mauritius and represents the largest national provider of jobs (Institute for Environmental and Legal Studies, 2004). The sugar industry was introduced in Mauritius by the Dutch in the 17th Century (Institute for Environmental and Legal Studies, 2004). It is also a significant economic factor in Pakistan (Environmental Technology Program for Industry, 2003). In the Philippines sugar plantations are also a major source of local employment and revenue with 675 000 workers and providing an income for 4.1 million Filipinos (Aldaba and Cororaton, 2001), with sugar cane factories producing up to 550 tonnes of sugar per day (Rouilland, 1990). Employment is also a major factor in developed and significantly richer countries such as the United States of America. Seventy eight percent of the Everglades Agricultural Area is covered by sugar cane plantations. These amount to approximately 155000 hectares and provide thousands of jobs (Coale *et al.,* 1994a). Sugar crops were established in New South Wales, Australia during 1874, where presently over 400 local people are employed (Lamb, 2001).

1.4 The chemical composition of sugar

Common names for sucrose are table sugar, white sugar and saccharose. Sugars are all carbohydrates. The commonly used term sugar refers to a wide range of carbohydrates which can be either monosaccharides or dissaccharides. Monosaccharides consist of single units and include glucose, fructose, and galactose (Pigman and Horton, 1972). Glucose is the most widely distributed sugar in the plant and animal kingdoms and is present in blood as "blood sugar". Glucose sugar is also known as blood sugar. It is the primary form of sugar that is stored in the body to utilise for energy. It is of particular importance to individuals who have diabetes or hypoglycaemia. Fruits contain fructose, which is also is found in honey and high-fructose corn syrup that is used extensively in soft drink production (Pignéguy and Pignéguy, 2007). Fructose is also called laevulose or "fruit sugar". Fructose and glucose are the main carbohydrate constituents of honey. Galactose is found in dairy products and sugar beets (Cramer, 1989).

Sugars can also form dissacharides. Galactose often combines with glucose to form the disaccharide lactose, otherwise known as milk sugar. Both fructose and galactose are metabolised to glucose for use by the body (Pignéguy and Pignéguy, 2007). All three forms consist of a single unit of sugar which are commonly known as carbohydrates. Sucrose is a simple carbohydrate which can be obtained from sugar cane and sugar beet, although sucrose occurs naturally in most land plants (Yudkin *et al.,* 1973) (Figure 3). It is a sweet crystalline non-reducing disaccharide which is formed by a combination of glucose and fructose units. These sugars are then

absorbed into the blood stream through the intestine wall (Yudkin *et al.*, 1973). The sugar of prime intereest in the context of this study is sucrose.

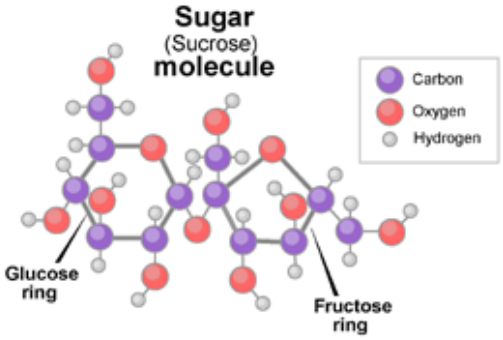

Figure 2. The molecular composition of sucrose which is a combination of glucose and fructose units for which the molecular formula is $C_{12}H_{22}O_{11}$ (Yudkin *et al.*, 1973).

2. The importance of sugar within Berber culture and tradition

Sugar is an important commodity in Moroccan life in that it is served at every meal and included in every beverage. It is significant in the lives of Berber communities because it represents a high calorie food in areas which often are dry and desolate and where nutrition is poor. More importantly sugar serves cultural and traditional purposes in that it has protective and supernatural aspects. It also represents a revered gift and bargaining tool being used to initiate negotiations between families. Examples of supernatural and traditional uses of sugar as well as its use as a bargaining commodity are provided in this section.

Mintz's concept of power is also referred to in relation to marriage and suicide. Marriage is shown to have a direct link to sugar whereas suicide is shown to be indirectly linked. Bourdieu's (1993) concept of habitus will also be referred to in relation to suicide. An overview of the culture surrounding death and dying of Moroccan nationals, who are also Muslim, is outlined in order to provide an insight into traditional and cultural aspects of Moroccan life. The habitus for a Moroccan national of Muslim belief presents an overall picture of how the world is, and guides them as to what they should think and how they should behave. It shows how females have little if any control over marriage negotiations. In regard to death; in particular, it shows how death should be in relation to rites and traditions that should be performed in order to enter the afterlife. The strong traditional and Islamic beliefs of a Moroccan means that even though an individual has the ability to make what could be limitless choices, the choice made is based not completely on free will but on the basis of inherent beliefs and traditions, i.e. by habitus. Sugar is shown to be linked to both power and habitus.

Berbers, particularly the community of interest in the Rastabouda area, believe in the continuous presence of various spirits (djinns) **(**Khalaf, 1996**).** In a Berber household on the 7th day of life a baby is prepared a special meal which is called bcica (Paque, 1984). It consists of rosemary, coriander seeds, semolina, olive oil and sugar. It is rolled into balls and placed in corners of the house in order to introduce the new born to good 'jnin' or 'house spirits' (Paque, 1984). Whereas salt is believed to infuriate house jnin, sugar is believed to 'sweeten' them or please them. One could argue opposing forces are in play. However, sugar exerts control over house spirits and

ensures that no harm comes to the newly born baby or the mother so long as it is present.

In making a gift intended to show marital intentions, Berbers employ a specific method of sugar production along with refining methods for producing sugar of fine quality. In traditional Berber society, a man is expected to present the finest white sugar to the father of the girl whose hand he wishes to secure in marriage. It is fathers who exert absolute power over marriage negotiations and have the final say in either objecting or permitting a union to take place (per's com Squalli Mohammed: Fez Administration: Morocco). Sugar is the means by which intentions are revealed, unspoken respect and thoughts conveyed, and marital negotiations initiated.

Although marriage negotiations begin with the presentation of a gift of sugar to the father of the female of interest, the male initiating the negotiation has spent many hours prior to this harvesting, processing and refining raw sugar cane. Men who seek a female's hand in marriage are responsible for producing their own high quality sugar to present as a gift.

A man in a Berber community wishing to secure a girl's hand in marriage offers a gift of very refined high quality sugar in order to acknowledge the innocence, purity and virginity of the focus of his affections whilst at the same time evoking pride and power in the father as having a prized daughter who is valued enough to be coveted. To purchase a bag of sugar with its inherent impurities in lumps, uneven grain and colour then present this, however exquisitely wrapped, to a father of a prospective

bride would be equivalent to calling his daughter a prostitute. This would not be looked upon at all favourably.

Traditionally, sugar cane was “clayed” (Galloway, 1977). Sodden clay was placed over sugar cones and water percolated through the sugar. This left traces of molasses that leached out resulting in the sugar on the top of the cone becoming whiter and of a quality far superior to that of the mass produced product for general daily use (Galloway, 1977).

The clay method was a time consuming process and employed very labour intensive methods. It also served as an overall test of patience. Furthermore the process provided a test of male restraint and therefore reflected his ability to be a good husband and caring father during pregnancy and sickness (per’s com: Rhannam, 2005, Fez Administration: Morocco). The process also has other associations. Often a mother or sister assisted in this process to make the ‘suffering,’ in terms of the young man’s yearning heart, lighter and easier to bear, thus bringing together a family with the main aim of securing matrimony. Overall the process reinforces social structure and the powers evident therein.

Whereas in many Western countries a box of candy can be hastily and easily purchased from a retailer, favourably wrapped, and even ordered for delivery, in Berber society there is much more thought, patience, and labour associated with the commodity as well as underlying deeper and expansive meanings. This is not to say that the same underlying meanings are not present in a gift of confectionary in Western society, but rather that the meanings inherent are more obvious and clear in

Berber society. The perceptions in the act, as well as the underlying meanings, are at the forefront of Berber individual thought, family acceptance and overall community expectations.

It could also be argued that it is not so much the confectionary in Western society per se that is prized but rather the quality of it. This is undoubtedly reflected with the presentation of fine quality sugar as a symbol of intention towards a daughter and also presents many unspoken analogies between the sugar and the female coveted in Berber society. Where in Western society a gift of high quality confectionary may have little meaning, to extended family in Berber communities there are extensive meanings immediately apparent to the community, family and individual.

Sugar, in Berber communities has historically been difficult to obtain, labour intensive to produce in its purest form, and expensive to purchase in times of drought and war (Bennasser, 1998). More traditionally and perhaps more relevant is the silent association of the qualities of sugar, sweetness and purity, which are likened to innocence and virginity. The value attributed to sugar in Morocco is partly reflected in its meaning (Nisbet and Verneaux, 1970). It is interesting to note then, that in remote Berber villages the time consuming methods of traditional preparations of sugar are still performed today unlike the more commercial methods of production, which declined in Morocco in the 19th century and are now all but extinct (Galloway, 1977).

Mintz (2005) refers to ‘older dates when a gift of confectionary was prized’. It could be argued that gifts of Valentine’s Day chocolates or sweet cakes filled with sugar in Western society are no more than a mere dilution of the more prevalent, and what

could be argued, a more ‘pure’ form of action; that of gifting high quality sugar for the purpose of initiating marriage negotiations after having actually processed and refined the sugar oneself as was common in Berber culture for generations and is still practised in some rural villages. Where commercial production of sugar resulted overall in little long-term benefit for Moroccan nationals, in particular Berber workers, traditional methods still retain significance.

Traditional preparation of fine quality sugar by the ‘clay’ method clearly exerts power in the form of relationships, both within the family and with regard to the wider community. However this traditional process does appear to render the actual focus of a man’s intention, the woman he desires, as a helpless pawn. The father of the woman enters into negotiations with the man who desires his daughter’s hand in marriage and meets with the family to discuss and decide the outcome. These meetings are opened as a result of the presentation of sugar as a gift and appear to render a woman as being at the mercy of the men in her own family as well as of men in the wider community.

However, this is where a paradox arises. Berber women are fully permitted and encouraged from a very early age to exert their own thoughts and feelings in a rather dramatic and artistic form, thus taking back the ‘power’ that supposedly belongs to the men surrounding her. This becomes evident in the form of verse which girls / women are permitted to sing in the presence of the man who has shown interest in securing them as a wife. These verses are very often ad hoc and composed in response to individual situations, where personal thoughts and feelings, attitudes and desires are expressed (Joseph, 1980). Whilst men use sugar as the negotiating tool, Berber women compose songs or poetry whilst awaiting the outcome.

The majority if not all Rif Berber women are able to compose poetry and verse and chant or sing them. They have both a sexual and social function, but essentially they allow women to address not only their fathers and immediate family, but also the whole community (Joseph, 1980). Such activities would allow women to retain their individuality and reclaim power with regard to a marital and 'bargaining' process which seems to render women objects rather than individuals.

Joseph (1980), gives an example of a verse sung by a woman in response to a marriage offer which she does not favour would go something like this:

"Wa-Allah. Our baddilkh wadda-ira woul Swadda-ourir. Addathizakh l'mizane yili lawfa iwannarikh."
This roughly translates:

> I swear that I will not change the person whom my heart loves
> with the other whom it does not love.
> When I put them both on the scale the one who has more value is the one whom I love and the one I want.

This is representative of a verse composed by a Berber woman in the region Beni-Sadden, North of Fez.

Adding to Joseph (1980), it is not only women that sing in verse, but a man can reply in verse also. So in essence it is possible to form a dialogue that would normally be unacceptable if purely spoken yet is acceptable to sing or chant. One could argue this

is not unlike Rap music in Western society. Further studies in this area may also result in more knowledge of the underlying power struggles between genders and also between different Berber communities.

In addition, verse is used not only to criticize social structure within their own communities but also to attack countries of Europe and, in particular, those countries which hire Berber labour and in doing so introduce new patterns in tribal life which often result in social upheaval (Joseph, 1980). The sung verse clearly represents strong traditional expressions which have persisted for generations yet Berber verse has only recently been attributed importance by anthropologists.

Verse reflects a very fascinating and remarkable inner structure to Berber communities where power is not as fully controlled by males as it first appears. Yet, at the same time the songs also support the patriarchal system as the verses sung, either by women or men, never attack the institution of marriage itself but rather serve only to discourage unwanted attention. Females themselves are not given the sugar and have no other way to communicate their thoughts and feelings other than in verse. The emphasis is on patriarchal negotiations using sugar as the negotiation tool. This ultimately results in the community remaining under the power of fathers within the home and men in society as a whole in that it is fathers and men who ultimately decide on marriage between their daughters and available bachelors.

Overall, and possibly most important to Berber women, is the fact that these songs allow the possibility of preventing a marriage to an individual they dislike. Joseph (1980) concluded his research paper on verse and Rif Berber women by stating that

apart from the songs, a woman has no way of discouraging an unwanted or hated fiancé other than threatening or attempting suicide. Suicide is actually quite high in Moroccan nationals, many of which would be Berber descendants. A topic discussed further in the following section (see section 2.1)

As already mentioned, the tradition of singing verse as well as related festivals and traditions were not attributed with any importance, for many centuries, by visiting Europeans. This attitude also extended to religious festivals which followed the introduction of the Qur'an and teachings of Islam after the Arab Conquests of the 7th Century. For example, traditional customs in relation to Sunni Muslim festivals and the Sunni celebrations themselves respected by Berber communities were ignored or given absolutely no importance by early travelling Europeans who deemed such celebrations 'antagonistic' to higher Muslim beliefs and values (Hammoudi, 1995). It was not only traditional customs that were ignored, including the offering of sugar to jnin, and as a gift during marriage proposals, but also Sunni Muslim religious festivals. Unfortunately this resulted in early anthropologists failing to recognise important social structures which were reflected in both traditional and religious festivities (Hammoudi, 1995).

As a result, early anthropologists failed to recognise and subsequently acknowledge fundamental factors lying at the foundation of Berber society and hence within individual Berber communities. An example is the importance of gifts in affirming communal solidarity, patriarchal dominance and the importance of traditional and subsequent religious obedience of the wider community (Hammoudi, 1995). Completely missed was the fact that the overall structure of the community represents

a code, which preserves the community, yet subtly masks more private symbolism and meanings. This is underlined by the presentation of physical gifts such as the gift of food by women to men and children, and by men to fathers of a woman who is desired for a wife (Hammoudi, 1995). Early anthropologists also failed to recognise several other fundamentally important facts which contribute to the overall structure of society. For example there was no acknowledgement that feasts are complemented (not contradicted or opposed) by the masquerades that allow exhibitions of subversive sides of Berber society. These include hostilities towards elders, outsiders, and men to women and women to men as clearly depicted in women's freedom to vocalise their inner thoughts and feelings (Hammoudi, 1995).

On a wider scale, anthropologists and economists did not recognise the effect that the commercial sugar industry was to have on the nationals of Morocco. The sugar industry ran under the control of neighbouring countries and brought little benefit for Moroccan nationals, yet succeeded in quelling the hunger for sugar in Europe and America (Gottman, 1943). The environmental effects of the sugar industry in Morocco were to remain evident for many years after its decline in the late 19th Century, and many of those effects are evident today, and are discussed in section 6.

2.1 Sugar, power and death

Sugar appears to be linked indirectly to female suicide rate in Morocco, in that, women have very little control over marriage negotiations and may feel there is no other way out but to take their own life. Although there are no official data in relation

to suicide as a means to escape marriage there are data available on overall suicide rates for Moroccans in France and Morocco. Female suicide is recorded as being 50% higher for Moroccan women than for men (Khlat, 1996). Suicide may be the result of wanting to escape an arranged marriage which would be further compounded by the limitation of society in which women live. Moroccan men are able to build social networks both in their homeland and by solidarity found amongst immigrants when they go overseas. Women in comparison remain largely isolated within the home, both whilst living in Morocco and when having emigrated. However, violent deaths for both sexes in marriage unions are very frequent (Khlat, 1996). It could be argued that homicide is power at its most extreme in a society which has fundamental beliefs and strong traditional foundations from which it is difficult if not impossible to escape. However, suicide and homicide are not the only significant killers of Moroccan nationals and Berbers.

Myriam Khlat (1996) studied the overall health of Moroccan nationals. She found that overall death rates of Moroccans living in France are very low (Khlat, 1996:p59). In the 1980s crude death rates were 1.7 per 1000 (Khlat, 1996:p63). Males had a probability of living 5 years longer in France than in Morocco and 5 years longer in France than a French born male in France (Khlat, 1996:p67). Children, however, have the same survival chances. This shows that low economic, social and cultural disadvantages being equal between Morocco and France are outweighed by medical advantages of health care and free health services, which separate France from Morocco (Khlat, 1996:p68). This is relevant when looking at diabetes (see section 4), particularly in regard to obtaining insulin.

Recently Moroccan girls residing in Morocco had a mortality rate 12% lower than boys and those residing in France 33% lower than boys. However, it is evident that health figures do not consider all factors (Khlat, 1996). For example, there are under-registrations of deaths in Moroccan villages, especially in rural communities where societies are poor and illiterate. The recording or reporting of death is not accurate, so data in existing literature is lacking. This appears to be an issue in regard to accurate information in respect to many facets of Moroccan life, including, as is shown later, in respect to historical records (see section 3) and accurate scientific data (see section 4).

A further consideration when looking at mortality is a Moroccan national's preference to choose where they die. Unlike many cultures, Moroccans often plan their death. A Moroccan national can find family comfort at home as well as an overall acceptance of what they consider the natural progression to death. This choice is incredibly important to Moroccans, and is immensely relevant to their beliefs. This is not a part of French culture. Another consideration is the costs involved in death (Khlat, 1996). It is cheaper to die in Morocco than overseas, but most importantly once dead the body is subject to all the Islamic funeral rites that in France are reserved solely for the wealthy minority (Khlat, 1996:p74). Added to this are the administrative formalities of dying abroad, a process which can be viewed as horrific for illiterate Moroccans with deep traditional and religious beliefs. Many Moroccans, particularly Berber, see it as better to anticipate death and travel to their 'homeland' than to find they are dying in a foreign country, unable to travel and live their last days in a state of regret.

Even though studies showed that the reasons for returning home were negative, they also showed positive aspects. It enabled individuals to take control of their own death.

It allowed families and communities to carry out rites and traditions that were removed from them if living in France (Khlat, 1996). It seems that power over one's life was returned to Moroccans once death was imminent. This becomes even more important and pertinent when it is realized that death to a Moroccan and in particular to a Berber is seen as the beginning of life rather than the end of living.

The final decision then, may be one, which does not take into consideration all possible choices, but rather those that relate to their 'habitus' in relation to their own beliefs, ideas, traditions and experience. To marry someone that is objectionable in the eyes of a female, or to die overseas may not necessarily be plausible options, as too would be to have a non-Islamic funeral. This meets Bourdieu's idea that habitus reproduces, reinforces and generates regular practices that make up social life. This can be further extended to sugar which has been shown to have a secure place in superstition, tradition and culture not only within Berber communities but also in general Moroccan society. In particular, the Moroccan tradition of tea drinking, which generates a regular and particular daily and social practice incorporating a desire for processed sugar and which contributes to poor Moroccan health throughout the country.

2.2 Sugar in relation to power and habitus in Morocco

Berber communities within Morocco in North Africa hold sugar in high regard, not only as a luxury commodity made ever more relevant by the labour and time required for its production but also because sugar can act as a social marker and a symbol from

which is made clear certain intentions. This is evident in many traditional beliefs, and can be related to individual, group and community power structures and systems.

Both the subtle and obvious power that sugar exerts over everyday life is revealed when looking at special occasions and important life events such as birth and marriage. Sugar is a significant factor in the protection of a new baby, as a bargaining resource in relation to marriage negotiations and as a factor which assists in maintaining patriarchal power throughout generations within Berber communities. The value of sugar and its significance in Berber culture directly relate to the idea that sugar represents 'good' or alternatively, as Mintz describes 'good and pure' perceptions or values. Understanding the traditional methods of processing sugar cane serves to emphasise the importance of sugar quality and purity and gives a greater appreciation for its value as a gift.

Foucault (Foucault, 1979; May, 2006) argues that "Power is everywhere…because it comes from everywhere". In relation to Morocco this could be argued to be literally true. Power is exerted over the population via accepted norms, values and superstition and folk law.

Islamic teachings are important in that, it is these teachings alone which determine what is right and wrong, acceptable or deviant. General Islamic teachings give extensive instruction on how to live, what to believe and also how to die. Its teachings enforce particular belief systems and ways to live which are considered 'normal'. These norms are widely accepted and extend across the country, leaving any alternative choice or option unacceptable in the face of the 'normalized' way to live.

Subsequently this results in ideas and beliefs becoming 'undeniable truths' and allows the population to view the world in a very particular way (Gupta, A. 2006). Any other options, even though options may be limitless, are therefore ignored or even incomprehensible. Therefore power is exerted in the most subtle yet most binding way in order to meet conformity and thus Bourdieu's concept of habitus is enforced.

3. An historical account of the sugar industry in Morocco

The following section outlines how the commercial sugar industry developed in Morocco. It provides an historical timeline which spans the Arab Conquest and the Industrial Revolution, as well as the introduction of the Qur'an, and puts sugar in perspective relative to other significant events. It shows that the introduction of slavery had a major impact in Morocco. Slavery is discussed in relation to Mintz theory of power and linked to the attitudes and sympathies of housewives in Europe. European women of the time believed that their duties were solely inclusive of completing domesticated household chores from which slaves were removed. European women considered black female slaves to be oppressed, on the basis that they were removed from completing domesticated chores. The discussion around slavery shows that the domesticated European woman, were similar to slaves. The evolution and manipulation of technology is also discussed in relation to labour and lays the foundation for introducing health issues. The health of cane workers and the environmental impact of sugar mills are introduced.

3.1 The 7th – 9th Centuries: the introduction of sugar, the Qur'an and slavery to Morocco

During research it became apparent that there is an absence of comprehensive studies of sugar during the medieval period. This has left a gap that historians continue to struggle to fill, particularly with regards to quantifiable data as well as production volumes and comparable figures which could have been used to compare production changes over time (Gottman, 1943). Historical documents showed that during the late 7th century Arabs spread across North Africa reaching Morocco in 68_2 (Galloway, 1977). This was responsible for two major introductions to Morocco: sugar and the teachings of the Qur'an. Over the subsequent two centuries there were slow but significant changes in Morocco in relation to societal structure, inhabitants and crop production (Galloway, 1977). For instance, in the two centuries which followed the Arab conquests, the commercial sugar industry was established. Interestingly, up until this time most Berber groups were reported to have been Christian. Prior to this they held a mixture of beliefs including sun and moon worship, and witchcraft-like beliefs that included various forms of indigenous rituals (Harrison, 1974). Some of these rituals included the use of sugar as already discussed. In modern days most Berbers are Sunni Muslim (Harrison, 1974), although many still hold beliefs in the supernatural and witchcraft, which is reinforced from an early age through verbally communicated tales of folk law, as is evident in Berber communities in Rastabouda. Further development of the sugar industry in the Mediterranean paved the way for an agricultural revolution (Galloway, 1977). The Agricultural Revolution along with the

introduction of Islam subsequently resulted in both religion and a sugar having a tenacious grip on society.

The main characteristic of the agricultural revolution in Morocco included the cultivation of new crops, an increase in land use for crop cultivation, and dependence on irrigation. By 500 A.D, sugar was Morocco's new crop. It took over vast amounts of land and required intensive irrigation methods due to the hot and arid climate. With a new crop successfully established international trade opened with other countries, in particular trade flourished between Morocco and Europe (Gottman, 1943). Initially this was to have a positive effect on employment but in the end would lead to devastating effects not only on the environment, but on the overall health of the nation and the economy. It also had a negative impact on individuals as they were eventually forced into slave labour.

In the early 9th Century, the early stages of the agricultural revolution in Morocco, sugar crops were not exclusively grown on estate land, but were often divided between estate land and peasant holdings (Galloway, 1977). This was significantly different to near neighbouring countries such as Italy where sugar was grown on estate land and peasants were employed as cheap labour (Galloway, 1977). The actual management of land in Morocco also differed from that in other Muslim countries. For example, in Egypt the Sultan owned all the land and divided it for labour, but the land itself remained in the control of the Sultan who provided no guarantee of work for a family (Galloway, 1977). The land in Egypt was not inherited as it was in Morocco. As a result in the mid 15th Century Egypt saw an increase in the use of slave labour as too did Crete and Cyprus (Davis, 1986). These countries experienced not

only an increase in slave labour but also what was reported to be brutal labour (Galloway, 1977). This was initially quite different to the situation in Morocco.

In Morocco, peasant-owned plots existed peacefully next to large rich estates. The estates were divided into plots and tenants were assigned to farm the land as 'sharecroppers' who then surrendered a percentage of the harvest to the landowner (Gottman, 1943). There were tenants, farm hands and families working together on plots of land that were inherited by families. Farm hands were represented by individuals who received free board for work in the fields and family members were generally expected to work the crops also. Unlike other countries, in Morocco, during the early history of sugar, land and labour were divided and highly organised and slavery was rare if it existed at all (Williamson, 1938). Sharecroppers had the power to determine their own production and cultivation methods, which were aided by the introduction of developments in cultivation. New technology broke the uniformity of work which had become characteristic in other countries, and while Morocco sugar farmers were free to work the land as they saw fit, in other countries forced slavery continued to increase (Gottman, 1943). In many parts of the Mediterranean, slavery was the major source of labour. It was only a matter of time until the use of forced slave labour spread to Morocco.

Galloway, (1977) stated that by the 9th century 'forced labour', otherwise known as unpaid slavery, was firmly established in Morocco, yet remained less prominent than in Crete or Cyprus. Many slaves at the time were taken overseas to work rather than put to work in their home country (Sussman, 1994). They were taken in order to fill labour requirements in regard to the growing demand for sugar in Europe, in

particular, the growing demand in Britain and France (Galloway, 1977). However, due to lack of record keeping, it may be possible that Morocco may not have been as free from slavery as depicted in early manuscripts. As slavery increased in the Mediterranean so did the plight of slaves. Mintz (1985a), in his analysis of sugar and power, quotes from an Abolitionist's speech:

> "in every pound of sugar used we may be considered as consuming two ounces of blood".

This was directly related to African slaves who worked the plantations, many of whom were black women. It was the 'plight' of black African women slaves who worked the sugar plantations that struck a chord with housewives in Europe (Sussman, 1994). Domestic women in Britain began to feel unrest, not because slaves were forced to work but because female black slaves were taken away from the domesticity of the house (Sussman, 1994). In Western society today both domesticity and forced labour could be argued to be types of slavery, of which one was forced and therefore labelled slavery and the other enforced by encouragement of a socially accepted norms resulting in the obedient housewife.

It was the white British housewife's stance against anti-slavery that helped secure white British women's political empowerment. Aiding this was their abstinence from slave grown sugar. This in effect forced cultural recognition of others and re-negotiated British cultural identity as well as long held gender roles. Women therefore became an innovative and influential form of political agency as a result of their role in the anti-slavery movement (Sussman, 1994). Yet, however much white British woman believed they were taking a stance against the slavery of black women, it is

apparent that both situations resulted in roles which had inherent restrictions, kept in place by overall power relationships. This interplay of roles was what kept both housewives and slaves living within expected, socially reinforced and encouraged norms and 'habitus', thus meeting expectations of their respective communities and wider society.

Mintz (1974) discusses resistance strategies for slaves with regards to pleasantries afforded them during enslavement and how they were 'permitted' to construct their own societies within their master's monopoly of power (Mintz, 1971, 1973, 1974). This was not unlike the 'enforcement' of Western domesticity of the time. Mintz also linked sugar not only to slavery but also to Britain's growing colonial strength, and in doing so focused shame on even the 'smoothest political operative' (Mintz, 1985). It was 'foreign' men who made all decisions and also oversaw every important political, economic and social decision. However, as slavery became an 'issue', this power was to shift from men to women and some would argue, from landowners to the slaves themselves (Sussman, 1994; Mintz, 1998). Morocco has a very patriarchal system in which men have the greatest power and in particular, over women.

Whilst white women identified with black slaves relative to their own domestic situation, white European woman actually considered themselves 'free'. They sympathised with the situation and roles of black African women slaves, but did not immediately relate their plight to issues relevant in their own roles in society (Davies, 1984). The British housewives recognised themselves not as a type of slave but as compassionate domestic women who were able to draw a parallel and sympathize with black women slaves purely on the basis of exclusion from domestic life

(Sussman, 1994). These views did allow the white European domesticated housewife some underlying power as evident in the refusal to purchase slave grown sugar. The refusal to purchase slave produced sugar was a resistance strategy used white European women which was 'permitted' and 'tolerated' by men in the household and society at large. Men of the time viewed this as 'quirky' or 'humorous' and therefore saw the abstinence of women as a pleasantry they afforded their women-folk. Therefore, it was the men who permitted their wives to express themselves. This is similar to the 'pleasantries' awarded to slaves, and the 'resistance' strategies employed by slaves which Mintz (1974) outlines. The idea of being awarded pleasantries and allowed to exhibit resistant strategies were equally applicable to European domestic housewives by the husbands and by masters of slaves. Therefore, a housewives role or place within European society was similar to the situation of the black female slaves working sugar plantations.

White European women continued to fill their domestic roles. Meanwhile, slaves continued work the sugar plantations, chopping cane stems by hand and then crushing them in hand-held vices. The canes were then milled and stacked before being transferred to a press which was modified from an olive plantation, for use in the sugar cane industry. This was also the situation in Morocco, where sugar was now an essential source of calories, a flavour enhancer and centrally important in festivals and religious feasts. Moreover, sugar represented a crop that was much easier to grow, with the aid of irrigation, and which used fewer resources and less land space in comparison to alternate crops rendering the same calorific value (Mintz 1985a). For example, one acre of land would yield eight million calories if planted with sugar cane, excluding the use of any by-products. It would take approximately four acres of

land for potato crops to yield eight million calories. A staggering 135 acres of land for beef production would be needed to equal the same calorific value as one acre of land planted with sugar.

3.2 The 10th - 20th Centuries, development of commercial methods of sugar production and the replacement of local crops with sugar cane

Even though there were no specifically designed machines to refine sugar; rather machinery was 'modified' from existing olive plantation machinery this proved to be more energy and labour efficient than traditional methods (Galloway, 1977). It was not until The Crusades of 1076 that methods were improved by introducing water-powered mills. Historical records indicate that there were 14 sugar mills in Southern Morocco utilizing water-power from aqueducts running from the Atlas Mountains. Technology developed slowly and further advances were eventually made in the design and implementation of a three-cylinder mill run by horses, oxen, wind or power. This required only three people, hence needing less labour in numbers of men (Galloway, 1977). This produced a general quality sugar. To produce even better quality sugar required more labour.

To obtain just a 'good' quality sugar, the sugar cane required continuous and repeated dissolving of crystals in water, followed by boiling, re-boiling and re-crystallisation at which time it was graded into powder, lumps or loaves. This method still exists today in some areas of Morocco where sugar can be purchased in any of these forms

dependant on the object of its use. However, this type of sugar is not considered 'fine quality', not possessing the attributes of high quality fine sugar that is required in order to pacify jnin or open negotiations with the intention of marriage. As the sugar cane industry began to expand and foreign demand for sugar increased, farm land in Morocco was planted with sugar cane, rather than used for grain or grazing. By the 14th Century, Morocco grew sugar cane successfully and was exporting to Italy (Gottman, 1943).

Nearing the end of the 15th century sugar was no longer manufactured and exported as a finished product from Morocco. Refining was moved to Europe. This resulted in a shift in power from the local producer to the importer. It reduced the need to make fine quality sugar in the country of its growth, Morocco (Galloway, 1977). The producers became subservient to the importer and the producer dependant on exports, as it the case in the 21st century. This shift in control was a major contributing factor which began the start of the decline of the sugar industry in Morocco.

Morocco already had a naturally grown sugar substitute used in daily life. Sorghum was a wild growing sugar substitute already commercially manufactured in Casablanca and was a traditional crop grown without the need for irrigation and which matured in two months (Galloway, 1977). However, sorghum was not as sweet as sugar produced from sugar cane. As a result no amount sorghum could appease the appetites of Moroccan natives for good quality refined sugar. Moroccans had become accustomed to an abundant supply of well refined sweet tasting sugar which the population demanded (Galloway, 1977). This was to become a significant problem as the sugar industry entered decline (see section below). During the Napoleonic Wars,

sugar substitutes were introduced to Morocco but the nutritional content was lower than for sugar and Moroccans refused to accept anything other than 'real' sugar in the packaging they had become accustomed to (Galloway, 1977). The demand for refined sugar removed any chance for a revival of sorghum. For all the associations' sugar held with slavery and brutality, it had proven itself to be an invaluable source of 'food'. It developed a firm hold not only at political and economic levels but also within society which still persist today (Mintz, 1985b, 1996b).

Another major factor contributing to the decline in Mediterranean sugar production came from an unexpected quarter. In 1537, the British King, Henry VIII abolished monasteries in the United Kingdom. Monasteries had a heavy reliance on candle wax (Mintz, 1996a,b). As candle wax demand reduced so too did honey production. This opened a door of opportunity for refined sugar to expand and take the place of honey. Sugar not only became a 'saviour' with a 'good' connotation attached, but unlike honey had an association with luxury and pureness as well as being viewed as rather exotic due to its origins, which at the time were seen as rather romanticised and mysterious (Mintz, 1996a,b). A positive, pure and romanticised view of sugar contrasted acutely with famine, loss of economic power, damage to the environment and the slave trade.

The decline of the sugar industry also coincided with civil strife reported to have occurred in 1576 (Galloway, 1977). This was followed in 1603 with reports of damage to sugar mills as the result of civil unrest. In 1622 Antony Sherley, an English merchant, reported the Moroccan sugar industry no longer existed (Galloway, 1977). An industry that took centuries to establish declined rapidly over approximately 25

years. Whilst the stone sugar mills lay in ruins in the deserts of Southern Morocco, sugar consumption in Europe continued to increase (Mintz, 1985a, b, c).

The implications of a heightened European demand, along with the decline of the sugar industry, were to be evident in the decades and centuries that followed. By the 18th century British aristocrats were reported to be "wallowing in sugar", and the working class were reported to be "yearning for it" (Mintz, 1985a, b, c). These demands fuelled the expansion of plantations and the continued increase in the slave trade as well as the introduction of taxation in neighbouring countries (Mintz, 1985a, b, c). During this time Morocco's once lucrative sugar mills remained idle. The potential for crop growth in Morocco and the presence of existing mills to process sugar were completely ignored. This could be argued to mirror attitudes to Morocco itself from the 19th century onwards. As the sugar industry all but disappeared in Morocco, so too did the presence and interest of Americans and Europeans.

During the 19th Century Morocco also began to suffer from a lack of water resulting in irregular crop yields which subsequently led to famine. The Gharb region (Figure 3) also had over 100 000 hectares of sugar plantation and normally had minimal rain (<500mm per annum) most of the year. But this was compounded by an even lower rainfall which coincided with the time sugar cane was maturing and therefore required the most water (El Mesaoudi, 1990). Prior to these severe drought conditions, irrigation methods, finance and engineering equipment and skills had been extensively employed and assisted by Europe. Now, as Morocco suffered from a severe lack of water, neither irrigation assistance nor financial aid from Europe was

forthcoming (Gottman, 1943). The few sugar crops that remained began to die from drought. Widespread drought in villages resulted in deaths (Gottman, 1943).

Figure 3. Outline of North-east Morocco showing the Gharb Region which covers the region Larache to Rabat, Meknes, Fes and Rastabouda. Rastabouda is marked with an arrow.

During 1937, the southern region suffered severely and people were well prepared to attack richer towns to take by force anything they could eat (Gottman, 1943: p180). This appears as somewhat of a paradox as some other areas of Morocco, particularly the Sous and High Atlas had more than 900 000 tonnes of potential harvestable sugar cane crop. The problem was neither a lack of labour nor of water, but rather of storage, harvesting machinery and transport. The majority of what could have been a profitable harvest was lost to wastage and decay (Gottman, 1943). Europe had no interest in either assisting with the harvesting of sugar crops in Morocco or

purchasing the sugar because Europe now had the ability to cultivate and produce its own sugar supplies (Galloway, 1977). Sugar crops that could have been harvested began to wilt, die and decay in the extreme weather which followed.

Extreme weather conditions coupled with what appeared to be a purposeful and decided lack of interest from Europe, resulted in irregular and uncertain local economics which in turn lead to overall insecurity (Gottman, 1977). To try and regain some control, the region became intent on saving water in order to irrigate crops when they needed it most. Water saving was fuelled by the need to ensure that crops survived. A critical element in economic development is the ability to successfully grow crops and harvest them (Ogolla, 1989). It is also a critical factor in agricultural development (Ogolla, 1989). Eventually France came forward to offer aid in the form of new irrigation methods. The introduction of these assisted economic stability (Gottman, 1943). It was the arrival of the French, between 1937-1939, and the modifications by them that resulted in wide-spread irrigation methods, which increased crop yields and the potential for self-sufficiency (Gottman, 1943). More irrigation resulted in an increase in output yet permitted an increase of stronghold of rule and allowed an easier path to adapt to changing demands (Gottman, 1943). Morocco's population increased and along with it the consumption of sugar, to which Moroccans had developed almost an addiction (Gottman, 1943). Due to an increase in demand and production remaining the same the supply of sugar dried up. By the late 1940s Morocco had no cultivation of sugar beet or sugar cane even though extensive potential existed for its growth (Gottman, 1943). This situation continued through World War II with Morocco once again not being able to control its own economic path, and again becoming of little interest to the rest of the world.

In World War II, as was the case in World War I, North Africa held no economic interest to any European country other than that of providing strategic military advantages (Williamson, 1937). Between 1942 and 1945 imports by the Allied forces were practically nil resulting in what was once a rich area becoming completely desolate (Gottman, 1943:p176). More importantly, sugar that was now being imported was not arriving into the country. On the decline of the availability of sugar beet and sugar cane Morocco had, in this period, become a major importer of refined sugar, tea and coffee as well as dairy products from overseas, but had now started to suffer from famine (Gottman, 1943). Morocco, along with the rest of the world, involved in the war, became subject to rationing. The first foodstuffs to be rationed were sugar, rice, tea, coffee and fats (Galloway, 1977).

The most serious deficiency amongst foodstuffs was sugar. Its importance was further compounded by many Moroccans who had a diet otherwise low in calories (Galloway, 1977). It was a time of national crisis in Morocco. Tea cannot grow in Morocco and had to be imported. Tea was, and is still, drunk in very large amounts with much sugar added to it. Drinking sugary tea is very much part of Moroccan culture. In 1943, Moroccans ate on average 67 lbs of sugar per capita, compared to Italians who averaged 20 lbs (Galloway, 1977). Due to the low calorific diet of Moroccans and the general unavailability of food, the authorities permitted the rationing of sugar which allowed Moroccans double the sugar quota than the people of France (Mintz, 1985a, b, c). As a matter of interest, General George Marshall obtained exemption from rationing in order to produce Coca Cola and was the only other exception made in relation to the rationing of sugar during WW II (Mintz, 1985a, b, c). Both these exceptions could be argued to be a significant strategy in

keeping civil peace whilst the world was at war. Sugar was shown to have the power to pacify the masses due to their desire for it (Mintz, 1985).

After the war, sugar imports increased to Morocco, at which time overseas attention was geared towards reducing aid to the Mediterranean and making them self-sufficient (Galloway, 1977; Hammoudi, 1995). Even with this aim, the potential for cultivation of sugar crops in Morocco continued to be ignored. This remained the attitude until a new vision appeared for the use of molasses, a sugar by-product. Molasses were suggested as cattle feed for Moroccan herds and the benefits would include a reduction in the amount of grain imported. This subsequently led to a reduced need for the irrigation of cattle crops and therefore an overall reduction in overseas assistance from neighbouring countries (Araba *et al.,* 1997). Grain imports were also expensive and also subsidised by Europe. These factors encouraged experimentation with molasses in the early to mid 1940's in regard to it being a source of fodder for cattle (Araba *et al.,* 1997).

3.3 1900-2004, sugar mill numbers decline worldwide

Mauritius and Cuba amongst others are similar to Morocco in that there has been a significant reduction in the number of sugar cane mills in poorer countries over the last century (Institute for Environmental and Legal Studies, 2004; Pippo *et al.,* 2007). This was mainly due to rich Western countries moving production in order to make financial savings. In addition, fewer mills can produce a larger output due to technological advances therefore making older mills redundant. During the 1960s,

Mauritius had 75 working sugar mills. This reduced to 19 working mills in 1995, 17 in 2001 and 16 in 2004 (Institute for Environmental and Legal Studies, 2004). A downward trend is expected to continue until there are only 4 or 5 working mills left which, due to technological advances will produce more than 6000000 tonnes of sugar per year, the majority of which continues to be exported to Europe and America (Institute for Environmental and Legal Studies, 2004). The Philippines presently have 35 sugar mills but sugar production has been decreased from 1993 through to 2000 from 2 million exported tonnes to 1.6 million tonnes respectively (Aldaba and Cororaton, 2001).

The development of the sugar industry in the Philippines was dependent on demand in the US which accounted for more than 80% of all their sugar exports (Aldaba and Cororaton, 2001). Since the early 19th century Cuba has been one of the biggest sugar-exporting countries in the world (Pippo *et al.,* 2007). Until 1959 the main market for Cuban sugar was the United States. However, as a result of the political differences between the US and Cuba following the Cuban Revolution in 1962, the US imposed a commercial blockade on trade with Cuba, ending Cuban sugar exports to the US and the sale of Cuban sugar (Pippo *et al.,* 2007). After the imposition of the blockade, Cuban sugar exports shifted to the former Soviet Union and Eastern European socialist countries (Pippo *et al.,* 2007). Almost three decades later, in 1991, this market abruptly disappeared with the collapse of Communism in the Soviet Union and Eastern Europe (Pippo *et al.,* 2007). Since 1991, Cuba has been struggling to rebuild its sugar production and market, since sugarcane production fell, from 80 x 106 in 1991 to 24 x 106 metric tons in 2004. In 1999 there were 155 active sugar mills while in 2004 there were just 85 active mills (Pippo *et al.,* 2007). After the Civil

War, the United States realised it could import sugar much more cheaply from overseas, hence there Americas sugar cane industry also declined (Escalona, 1952; Brown, 1999).

Today, the most well-known sugar refinery in Morocco is Dar El Gardari. Yet this has been reduced from a primary producer of sugar with independent economic standing to complete reliance on economically richer countries in order to run (Cordova, 1998). This is a situation which has persisted for generations and has resulted in the filtering of power from Morocco to Europe resulting in an overall dependency rather than an equal relationship between these countries.

4. A general overview of Moroccan health in relation to sugar

Khlat's (1996) stated that Moroccans pride themselves on low alcohol consumption and generally believe that this protects them against cancers. Science has shown that a low alcohol intake may protect against cancers of the mouth, pharynx and oesophagus and, that a diet high in fruit and vegetables protect against intestinal cancer, stomach cancer and breast cancer. However, low alcohol consumption and a diet rich in fruit and vegetables does not explain the low level of reported Moroccan mortality figures due from cancers. This is also the case with regard to diabetes. This section will discuss the claims of wellbeing and health in Morocco and will show that it does not necessarily follow that even if Moroccans ate a diet high in fruit and vegetables and

abstained from alcohol, they have better health, but rather, that low cancer rates are more likely due to the fact that they have limited access to medical care and health professionals. In addition, this section will show that deaths and illness are likely to be higher than official figures present. The many and varied issues associated with sugar and the sugar cane industry in regard to personal health and environmental health will be shown to be present in Morocco and place doubt on the quality of food being consumed due to heavy metal contamination.

4.1 Diabetes

Medical issues and complications are often overlooked in Morocco due to the lack of resources and health professionals. Hospitals in Morocco are ill-equipped to cater to those dying of cancer or any other serious medical condition and hence patients are generally not well-diagnosed or treated. Therefore, the low rate of reported cancer in Moroccans may be a reflection of authorities sending individual's home stating the "need to rest" rather than committing to expensive treatments for which they are under-resourced. The lack of resources also extends to insulin medication which is needed for those who suffer from diabetes. It is not uncommon in Fez for insulin to be sought for up to six hours, chasing from one doctor and pharmacy to another in order to fulfil a prescription. Available data shows that one of the main causes of death in Morocco is diabetes or complications due to diabetes.

The hormone, insulin encourages the conversion of glucose to glycogen (Ford-Martin, 2004). Ingested food is converted into glucose which is then absorbed by the

intestines and released into the blood stream (Ford-Martin, 2004). People who develop diabetes either do not make insulin, or are unable to use insulin properly, or both, resulting in a high blood sugar level, that is, a high level of glucose (sugar) in their blood. This can result in feeling tired, hungry, or thirsty. Other symptoms may include loss of weight, a need to urinate often, having trouble with their eyes, kidneys or nerves. Diabetes can also cause heart disease, strokes and can result in amputation of limbs (Ford-Martin, 2004). The greatest increase in recorded diabetes was observed between the mid 1980s and early 1990s when Morocco's expenditure on sugar and sweet foodstuffs doubled (Khlat, 1996).

Deaths due to diabetes of French Moroccans, that is Moroccans that immigrated to France, are 1 per 1000 in males and 2.8 per 1000 in females. Moroccan women are less likely to gain treatment for diabetes yet are reported to be more likely to have complications (Khlat, 1996:p89). There are also clear gender differences between the occurrence of diabetes in Moroccan men and Moroccan woman who reside in Morocco, with women being more prone to sugar related illness and mortality. This is thought to be a reflection of differences in eating patterns and the fact that women stay home and are therefore much less likely to receive the same health monitoring as men. This trend is not significantly different for women living in France (Khlat, 1996:p88), which appears to substantiate this theory. Moroccan women in France have a higher mortality from diabetes than French women because of a high sugar diet (Khlat, 1996:p88), yet in France overall diabetes mortality is reported to be decreasing due to insulin therapy and education in regard to improving eating habits. However, investigating this data further showed that the figures stated for women incorporated all French residents and did not differentiate between Moroccans and French. Further

research in this area in regard to separating diabetes sufferers into respective nationalities may show significant differences. On the basis of Khlat's report (1996), figures show that Moroccans who reside in towns and cities within Morocco and also within foreign city limits are more subject to diabetes than those who remain in villages. This may also not be accurate, especially in view of the fact that many village inhabitants are illiterate and have little if any access to medical resources.

Death from diabetes and associated complications as well as from cancer and numerous other inflictions may well be under reported due to both a lack of diagnoses and the fact that much of Morocco's population remains illiterate. In addition, the Moroccan population, and Berber communities, in particular have scant, if any, access to legal recourse, medical attention, counselling or support (Delaney, 2007). This is put in perspective when looking at the ratio of doctors to patients. For each doctor in Morocco there are 2579 registered patients, making medical treatment difficult to obtain (M'Jid, 2003). Adequately trained professionals in the form of nurses, doctors, social workers, and child specialists, medical and paramedical professionals are severely lacking (M'Jid, 2003). Those individuals who are able to travel for medical purposes, to for example, France does so in order to be diagnosed and treated. Many are diagnosed with cancer and diabetes as well gastrointestinal diseases, and are subsequently treated in France or other neighbouring countries.

Another great killer of Moroccans and a disease of at least a third of the world's population is Tuberculosis, thought to be primarily contracted from untreated milk (Mandouri, 2003). *Mycobacterium bovis* is an aerobic bacterium and the causative agent of tuberculosis in cattle (Tice, 1944). This is also known as bovine TB. Man

ingests this bacillus by drinking raw milk from infected cattle (Heiserman, 2006). In the 1930s, 40% of cows in the UK were infected with *M. bovis* and there were 50,000 new cases of human *M. bovis* infections each year (Reynolds, 2006). Since 1990, only one case of human *M. bovis* infection acquired from an animal source has been documented in the UK *(*Reynolds, 2006). *M. bovis* is usually transmitted to humans via infected milk, but can also spread via aerosol droplets. Although human infections are rare, primarily due to pasteurization of milk which kills bacteria, bovine TB is common in areas of the developing world where pasteurization is not routine, in particular in remote areas such as in many Berber communities in rural Morocco (Marih *et al.,* 2004)

This social marker is kept in place by yet another traditional act. Upon the return of the vessel that sugar is presented in, Berbers traditionally return the vessel by filling it with milk. It is widely known that TB can occur in un-pasteurized milk and can be spread easily from one person to another. However to return a vessel empty would be equivalent to wishing bad fortune on the recipient, hence the spread of Bovine TB resulting in respiratory TB in Berber individuals which is then easily transmitted throughout the community. For a society rich in tradition and customs it is equally fraught with internal and external power struggles, whether these are personal, social, or traditional.

Sugar represents an expensive and coveted gift considered far too valuable to present to another Berber community which leads to inner community marriages often with a view to marrying with cousins. Deemed an expensive luxury item sugar is not willingly presented to other Berber communities or non-relatives. This in itself results

in high incidents of congenital anomalies and mortality as well as reinforcement of community norms and values. Both diabetes and congenital diseases have been proven to be largely genetically influenced and can be linked to intra-family marriages. This results in high incidents of congenital anomalies and subsequent mortality (Khlat, 1996). Such diseases and social markers can be argued to have been ultimately guided through history by international politics and economics and furthered fuelled by European greed and power.

Control and power is exerted at every conceivable level within family, social, and global environments but more disturbingly with regards to health and longevity of the individual. For this reason many Moroccans choose to reside half a year in France where medical treatment can be accessed and life expectancy, in theory, extended rather than reside in Morocco and simply be told to go home and rest, which often means 'go home and wait to die'. The low cancer rate in Moroccan nationals may be more a reflection of poor medical attention and treatment rather than their diets of fruit and abstinence from alcohol, albeit a healthy diet aiding well-being and general health. Even though fines are payable for not reporting deaths, many still go unreported due to illiteracy and fear of authority.

Again the power of relationships, social order and structure are inherent along with expectations and traditional values. Whereas Moroccan men are able to, and in fact expected to, build social networks both in their homeland and by seeking solidarity found amongst Moroccan immigrants overseas, women are expected to remain largely isolated within the home. Women often do not work outside the home and therefore

receive significantly less support, medical attention, diagnosis and treatment. Child health in relation to oral health and hygiene is also significantly lacking.

4.2 Periodontal disease and tooth decay

A Swedish study concluded that dental caries have increased in Morocco overall, but in poorer areas with restricted sugar intake dental caries show no overall increase (Holm, 1990). More specifically, an epidemiological study comprising of 2383 Moroccan school children aged between 8 and 12 years old was carried out in order to determine the prevalence and severity of periodontal diseases in Morocco (Poulson *et al.,* 1972). The study showed that all children examined had periodontal disease including the occurrence of gingivitis which had developed into early destructive periodontal disease (Poulson *et al.,* 1972). The study also indicated a lack and obvious need for dental health services among school children (Poulson *et al.,* 1972). The occurrence of diabetes and its complications have increased all around the world but the increase in complications, including blindness, kidney failure, heart disease and amputations, are significantly great in Morocco (Boutayeb and Twizell, 2004). Sugar not only represents a problem with human health in Morocco, but also that of animals and the environment.

Although sugar intake is directly responsible for the high incidence of diabetes and tooth decay in Morocco, it may also be the case that sugar can be implicated in other illness and disease, albeit indirectly. In view of the environmental impacts caused by the presence of sugar mills it is probable that there are at least some deaths which

occur from digesting particulate matter during the growing and cultivation of sugar cane (see section 5), the processing and refining of sugar cane (see section 6) and digesting polluted water and, or food which has been contaminated by pollutants from the refining process (see section 7). These issues will be discussed further within the relevant section.

5. Environmental and health impacts

This section provides an overview of the impact that sugar mills had on the environment, specifically deforestation and desertification, due to the need for wood in order to fuel the mills. The methods used in growing and cultivating sugar cane crops, and in particular, the environmental impacts in relation to the fertilisation of crops using blanket techniques, and the harvesting of crops using burning methods are discussed. Reports showing how these methods affected water quality, the environment and the health of sugar cane workers are referred to.

A direct result of the introduction of the sugar cane industry was the felling of trees to supply wood as fuel for the sugar mills. Subsequently deforestation occurred, particularly in the 18th and 19th centuries. This resulted in the extinction of many native species, for example, Mauritius suffered the loss of numerous endemic species and many more are reported to be unable to sustain themselves (Institute for Environmental and Legal Studies, 2004). The forests in Morocco were already highly depleted due to their use for fuel for the sugar mills in the early 9th and 10th centuries. Eventually the continuous felling of forests throughout the 11-15th centuries had a major impact on the curtailment of sugar cultivation in Morocco's valleys. The

resultant lack of timber for fuel was a major factor in the decline of the sugar industry and increased the cost of fuel which ensured that sugar remained a luxury item (Galloway, 1977).

In addition, Europe realised that with the increasing price of fuel and lack of trees, expenses would increase. As a result sugar processing a refining was moved to Europe and the environmental cost to Morocco pushed aside. The once forest covered Mediterranean was quickly becoming barren, particularly with regard to damage to the once vegetative rich areas of the High Atlas regions in Morocco which now had severe or irreversible desertification. The forecast of a doom-laden future of water shortage, arid fields and a hungry America as outlined in Mintz book "Sweetness and Bite" could be applied to Morocco at this time.

Western countries, although often lax in adhering to environmental pollutant controls themselves, do have clearly stated pollution regulations and guidelines in place, requiring that toxin levels be constantly monitored for effects on people, land, crops, animals and plants. No such monitoring was introduced in Morocco. Whereas severe penalties are a possible repercussion in the West, there are no such penalties in Morocco. The adverse consequences of the sugar industry continued to be overlooked in Morocco until the last twenty years when there have been advances in research in respect to pollution levels of local rivers. By-products had not been researched in Morocco until the mid 1940s, even though disposal of by-products were major considerations in Europe and America (Ogolla, 1989).

Deforestation and desertification are still issues difficult to remedy in poor countries where the focus is on feeding the family and simply surviving. Economic, agricultural, industrial and political advantages were taken in Morocco by many countries with little thought for any lasting effects on Morocco itself or its indigenous people. Much of this can be directly related to political powers and the desire of other countries to be economically superior.

5.1 Impacts during growth, cultivation and harvest

The major global environmental consequences of sugar cane production include: nitrogen run-off as a result of the blanket fertilisation of crops, leachate containing herbicides. Nitrogen losses from sugar cane crop plantations in Australia have been shown to represent one of the most significant inputs to the surrounding environment (Isaa *et al.,* 2006; Coale *et al.,* 1994b). Irrigation coupled with over applications of nitrogen fertiliser results in contamination of adjacent sites (Lindau *et al.,* 1997; Thorburn *et al.,* 2003, 2005). Nitrogen fertilisers which are used to promote plant growth and sugar crop yields leach through the soil and end up in ground water and subsequently rivers, lakes and coastal oceans which include those of international fame such as the Great Barrier Reef (Kwong and Deville, 1994; CSIRO, 2007; Thorburn *et al.,* 2007). Nitrogen fertiliser has been identified as a major pollutant in both surface and ground water (Dobereiner *et al.,* 1995). Bundaberg groundwater is contaminated by nitrate leaching from sugar cane crops (Verberg *et al.,* 1998). The over availability of excessive nitrogen, in combination with post-monsoonal rain in autumn and winter in tropical climates, increases the uptake of water and nitrogen into sugar cane plants and subsequently reduces profitability in regard to sugar cane

growth (Berding *et al.,* 2005). The daily irrigation of sugar cane crops promotes mineralisation of soil organic matter and hence losses of nitrogen in to the environment (Thornburn *et al.,* 2003).

In the State of Sao-Paulo, Brazil the sugar cane harvest season coincides with the dry season (Monteira, 1975; de-Medeiros *et al.,* 2001). Over this period untreated wastes from sugar cane factories are pumped into local rivers where the waste accumulates due to low water levels and little water flow. This leaves the rivers unusable for any other purpose (Monteira, 1975). Sugar cane farming practices in north-east Brazil are generally unregulated and there are no guidelines with respect to the application of herbicides. These include the herbicide, 1,1'-dimethyl-4,4'-bipyridinium ion (paraquat, ortho paraquat, or gramoxone, Chevron Chemical Co), which is blanket spread over crops (de-Medeiros *et al.,* 2001). As a result, run-off from crops contain high levels of paraquat which has been shown to cause acute toxicity in local prawn (*Macrobrachium amazonicium*) and snail (*Pomacea lineate*) populations. Both species indicated an unexpected level of ecological vulnerability in that both showed sensitivity to the herbicide paraquat in orders of magnitude higher than predicted (de-Medeiros *et al.,* 2001). In other countries, alternative herbicides have shown similar effects. For example, in south-western Louisiana, fish stocks declined as a result of water being contaminated with run-off from adjacent sugar plantations where the herbicide 2-Chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine (atrazine, Shell Chemical Company) was used (Southwick *et al.,* 2002).

Herbicides have also been shown to be a significant problem in drinking water in Brazil (Coale *et al.,* 1998b). Drinking water was shown to have herbicide contaminant

levels above those recommended in Europe, USA and Canada of 0.5g L^{-1} for total chemical concentrations and 0.1g L^{-1} for any one compound (Coale *et al.,* 1998b; Lanchote *et al.,* 2000). A similar result was reported in south-western Louisiana which has sugar cane crops covering 17 000 hectares and where the herbicide atrazine was used (Southwick *et al.,* 2002). Atrazine levels in local drinking water were reported to have measured in excess of levels permitted for drinking (Southwick *et al.,* 2002). Managing sugar cane plantations in providing fertiliser and herbicides to maximise profit appears to have detrimental effects on the environment. Sugar cane workers also appear to suffer detrimental effects, in particular where women work the cane fields for more than 8 months whilst pregnant (Lima *et al.,* 1999).

The herbicides Paraquat and Atrazine are both used on the remaining sugar cane crops in Morocco as well as general agricultural crops. They have been responsible for accidental poisoning (Wesseling, 1997) as well as being linked to Parkinsons Disease (Anonymous, 1997), immunosuppression (Anonymous, 1996) and poisoning in humans and animals (Salmona *et al.,* 1992; Wesseling, 1997). Paraquat has been shown to inhibit growth and cause leukaemia (Magnelli *et al.,* 1989). Atrazine has also been shown to have inhibitory effects on growth (Anonymous, 2006) and cause cancer (Magnelli *et al.,* 1989; Son *et al.,* 2003) as well as ovarian and uterus disorders (Teak and Kniewald, 1992).

The continued industrial and agricultural development of the Gharb district between 9th and 15th centuries resulted in it becoming the most heavily polluted region in the Sebou (Bennaser, 1998). The Sebou River flows from the Atlas Mountains to the Atlantic Ocean via Fes and Kenitra with tributaries running from the Rif and Central

Morocco. It cut through all the major sugar plantations (Figure 4, next page). The availability of water in this area was the main reason for the development of the sugar industry in this area (Bennaser, 1998). However, these areas were not developed to deal with either industrial or domestic waste or supply of domestic water. As a result labourers lived in abject poverty and squalor, where pollutants were either dumped or leaked in to the surrounding environment (Bennaser, 1998).

The most polluted site in Morocco today is the sugar plant near to Sidi Allal Tazi. This site is contaminated by, ammonium and nitrate and has resulted in pollutant levels higher than those recommended in international standards, 45mg/litre (Nisbet and Verneaux, 1970; ISO 10694, 1995E). These pollutants have the potential to cause mental retardation, neuromuscular paralysis, cancers, heart disease and many other ailments many of which lead to death (Schiefer, *et al.,* 1997). There has been effort to remedy the presence of these chemicals in the environment and the environmental impacts remain unresolved and ignored by those who utilised Morocco's resources in order to gain economic benefit for themselves.

Unfortunately, even today, in a Berber village near Rastabouda, it is firmly believed that Down-syndrome children are born as a result of their mothers or fathers swimming in locally polluted waters from the once illustrious sugar mills (pers com Maache. L: local enforcement officer, Administration of the Circle Surrounding Fez, 2005). In addition the persistence of environmental effects has reached even the most remote of Berber villages. It appears that the power of European countries and America has been used to feed Europe at the expense of Morocco.

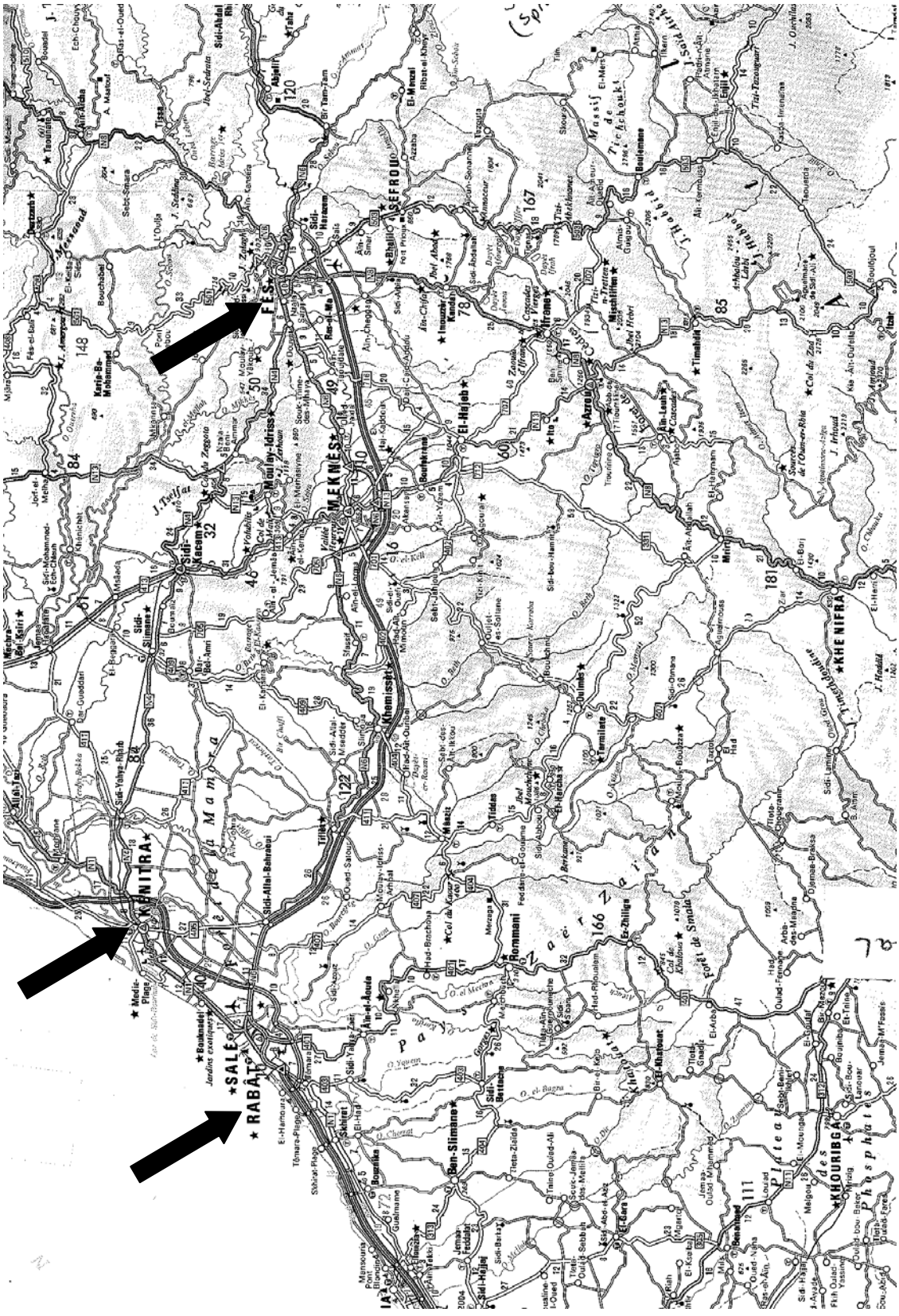

Figure 4. Map of the North-east coast of Morocco with arrows indicating the location of Kenitra and Fes. The Sebou River is 458 km long and originates in the Middle Atlas, runs through Fes and out to the Atlantic Ocean near Kenitra. The capital of Morocco, Rabat is also shown.

After crops have been harvested levels of particulate matter in the air have been shown to rise causing detrimental health. There is a positive correlation between high levels of particular matter and cardiopulmonary diseases, in particular, lung inflammation, asthma and chronic obstructive lung disease (Scapellato and Lotti, 2007). Other possible effects include cardiovascular problems such as arrhythmia, heart failure and myocardial infarction (Scapellato and Lotti, 2007).

5.2 Harvesting and sugar cane workers health

Once the sugar cane has matured and is ready for harvesting it is traditional practice to lightly burn the crops. This ensures cleaner cane for delivery to mills (Meyers *et al.,* 2005), and facilitates manual cutting (Basanta *et al.,* 2003).

The disadvantages to the environment include atmospheric pollution, and soil and water losses (Meyers *et al.,* 2005). Burning sugar crops also detrimentally affects subsequent seedling growth (Sampietro and Vattuone, 2006). The crop residues left after burning are known as 'trash' and contain high levels of nitrogen which can leach into groundwater (Prasertsak *et al.,* 2002; Thornburn *et al.,* 2004). Where there are poor nutrient and highly weathered soils, as is often the case in tropical countries, the soils are more susceptible to losses of organic matter (Feller and Beare, 1997). For example, in Brazil, sugar cane trash was shown to produce an inhibitory allelopathic effect on plants (Carvalho *et al.,*1999). This is a negative biochemical interaction between plants resulting from compounds produced by living plants and present in their residues, which may contribute to a decline in yield for sugar cane crops (Lovett

and Hurney, 1992; Ball-Coelho *et al.,* 1993). Research showed that 80% of dead leaf material and 64% of trash nitrogen were lost during pre-harvest burn (Ball-Coelho *et al.,* 1993), or remains immobile and unusable by plants, in the soil, and is ultimately lost as a source of nutrient to the crop (Basanta *et al.,* 2003). With regard to the quality of sugar, burning increases dextran levels in the finished sugar product (Meyers *et al.,* 2005), which affects economic profit by causing sugar crystals to elongate and the formation of false grain. In addition, dextran slows filtration rates during processing and affects the concentration of the final liquor during refining (Chou, 2000). There are also changes in labour requirements, in that less labour is required to burn crops than required to cut and clean it by hand, therefore having wider social and economic implications (Meyers *et al.,* 2005).

The burning of sugar cane is also reported to have deleterious effects on health (Arbex *et al.,* 2000). Asthma rates in Brazil have been reported to be high in sugar cane workers, particularly in the burning season when there is a correlation between total suspended particle concentrations and admission to hospital for asthma related complaints (Arbex *et al.,* 2007). Other studies show that admission to hospital for children (<13 years old) and the elderly (>64 years old) increases by 21.4% and 31.03% respectively during the burning season (Cancado *et al.,* 2006; Luke *et al.,* 2007; Naeher *et al.,* 2007). Other ailments are also said to be significantly high in sugar cane workers during this time, and include complaints such as rhinitis, bronchoalveolar lavage, lung cancer including mesothelioma (Rothschild and Mulvey, 1982; Amre *et al.,* 1999; Luke *et al.,* 2007; Naeher *et al.,* 2007). As a result of such studies there appears to have been a recent move away from burning sugar cane, particularly in India (Sampietro and Vattuone, 2006).

The mean birth weight of babies born to women who worked within the sugar cane plantations in Northeast Brazil have been shown to be 190g lower than those women who worked within other industries (Lima *et al.,* 1999). Often the women who work the fields are from low income groups and often have no alternative but to work in sugar plantations in order to provide for their families. The lower than average birth weights of children are thought to be a result of manual labour in the latter months of pregnancy but may also be related to chemical presence.

5.3 Impacts due to milling and refining

This section outlines the procedures used for milling and refining sugar cane after harvest. The by-products produced during processing and refining procedures are discussed along with the ways that they affect the environment. The wastes produced by sugar mills are also shown to result in heavy metal contamination, and parasitic and bacterial infections. Specific examples provide an emphasis on the affect that these factors have on water quality in Morocco. The remediation methods used by the Moroccan Government are also discussed.

There are five major operations (Aldaba and Cororaton, 2001) involved in the processing raw sugar cane.

Milling. The sugar cane is disintegrated into smaller pieces and passed through a series of heavy rollers at pressure in order to extract juice.

Clarification: Cane juice is clarified by treating with milk of lime to attain a pH of 7.5 to 8.5 and then heated to a few degrees above 100^{o}C. During this process suspended particles and impurities are trapped and settled allowing the juice to be drawn off and sent for evaporation.

Evaporation: The clarified juice is evaporated, until it gradually thickens to a syrup-like consistency containing 55% sucrose, 35% water, and 10% non-sugars.

Crystallization: The syrup is further concentrated by crystallizing the sugar. Boiling results in a constitution of about 75% sugar, 25% moisture along with impurities. Gradual cooling and crystallization then takes place.

Centrifugation: Centrifugation by high speed spinning then separates the molasses from the sugar crystals.

Following these procedures the product is then ready for refining which consists of the following steps (Aldaba and Cororaton, 2001):

Affination and melting: Affination is the removal of molasses which rises to the top of the mixture and forms a skin over the top.

Clarification: Carbonation, heating, and bubbling of CO_2 gas from the boilers into the mixture results in the formation of calcium carbonate (CaCO3) precipitate which entraps any suspended and insoluble impurities including ash.

Filtration: The mixture is then separated into a clear liquor and the calcium carbonate precipitate into.

Decolorization: Dissolved impurities and colorants are removed.

Evaporation: The liquor is then further evaporated in order to raise the concentration of sugar content.

Crystallization: The concentrated liquor is then sent to vacuum pans where sugar crystals are precipitated. The liquor is then further evaporated. When the optimum crystallization is attained, the crystal-molasses drop to centrifugal machines where they are purged to separate the crystals from the molasses.

The processing and refining of sugar may vary between countries due to the lack of or use of obsolete machinery. However, the overall general processes used in countries which possess modern machinery and transport can be illustrated quite simply (Figure 5, next page).

The sugar is then ready for packaging and export. Meanwhile these processes have produced significant waste products which have the potential to have a significant detrimental affect on the environment.

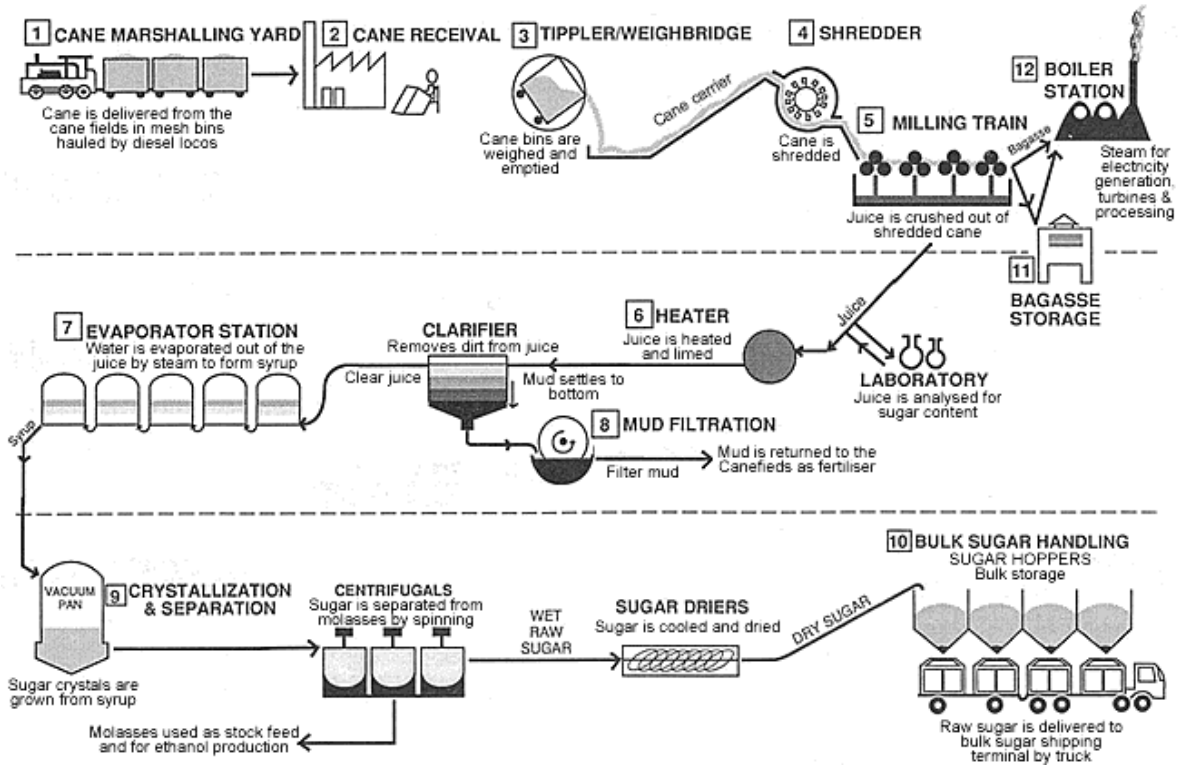

Figure 5. A simplified diagram showing the methods use to process and refine raw sugar cane. Adapted from a webpage published by the Queensland Government, (2005). (Department of Primary Industries and Fisheries)

5.4 Environmental effects due to processing and refining sugar cane

Pollution of the environment occurs from the use of cleaning fluids and machine oil within the mills. By-products are also a major source of pollution and include bagasse, molasses and other particulate and liquid wastes, in particular waste water from cleaning factory floors and machinery which containing heavy metals.

The whole process involves large amounts of water and steam which generates by-products such as bagasse, the fibre left over after the juice has been squeezed out of

sugarcane stalks, molasses, filter cake and ash (Aldaba and Cororaton, 2001). Harvesting, milling and refining sugar cane generates solid, liquid, and gaseous wastes. There are also additional wastes in effluent resultant from washing equipment, draining, spills, boiler scrubbers, cooling, machine oils, burning of fossil fuels and condenser water, spilled juices, and sugars, which are sources of high Biological Oxygen Demand (BOD) (Rouilland, 1990; Aldaba and Cororaton, 2001; Indab, 1996; Orbeta and Indab, 1997). BOD is a measure of the amount of oxygen that is consumed by micro-organisms as they decompose the organic components of waste matter. Waste water used in cleaning equipment, and factory floors, spilled oil and grease are high in suspended solids and BOD. Seepage from bagasse, filter mud and spilled canes is also high in BOD. Sugar mills have a long-established practice of discharging wastewater in local rivers, bays, creeks, and oceans. In the late 1980s, only about 37% of the mills had waste water treatment facilities (Aldaba and Cororaton, 2001).

In Morocco, obsolete technology and non-compliance to regional, national and international environmental regulations and guidelines in other countries, such as the Philippines, has resulted in the sugar cane industry being a major source of water and air pollution as well as a major producer of by-products; bagasse, filter cake and molasses (Aldaba and Cororaton, 2001). As in Morocco, older machinery is used in the Philippines, Cuba and Mauritius which results in inefficiency and generally a negative environmental impact, for all the reasons outlined above. Mauritius continues to deny any environmental impact in relation to its sugar cane industry but research indicates that its sugar mills produce high volumes of effluent which are also

high in organic content, fertilisers and herbicides (Institute for Environmental and Legal Studies, 2004).

Even in technologically advanced parts of the world such as Louisiana, USA, there is movement of soil, plant nutrients and herbicides in surface run off from sugar cane plants which include the herbicides metribuzin and atrazine (Bengtson *et al.,* 1998). Other problems include erosion, salination and degradation of land as evident in Cuba due to the introduction of sugar cane as an agricultural crop in 1989 (Gersper *et al.,* 1993).

Other organic and inorganic pollutants originating from the sugar cane industry include carbon monoxide, sulphur, phosphorous, sodium, calcium, magnesium, copper, manganese, iron, hydrogen sulphide, zinc, cadmium, arsenic and mercury (Environmental Technology Program for Industry, 2003). As a result local farmers who use the rivers for irrigation purposes use water which contains high levels of pollutants which are then found in vegetable crops (Opala, 2001; Rayment *et al.,* 2002). Other countries experience the same issues with regard to contaminants occurring in vegetables as well as drinking water. In poorer countries there are added issues with the lack of availability of fresh water. As 45% of the Nairobi population do not have access to piped or bottled water they have no alternative but to use the contaminated waters of the local rivers (Delaune *et al.,* 1998; Soicher and Peterson, 1997; Opala, 2001). The rivers in Nairobi should have a biochemical oxygen demand (BOD) value of 2mg/l or less. They actually have concentrations between 40 and 4400mg/l oxygen (Opala, 2001). The Ipojuca River in Brazil is also heavily polluted as a direct result of the sugar cane industry (Gunkel *et al.,* 2007). Brazilian rivers

suffer from high temperatures, acidification, increased turbidity, oxygen imbalance, and secondary contaminations such as increased coliform levels (Gunkel *et al.,* 2007). Vietnam has the same environmental issues (Manalili *et al.,* 2003).

5.5 The affect of milling on water quality in Morocco

The effects of pollution on Morocco's environment are similar to those discussed in the previous section. Morocco's water quality standards have been derived from World Health Organization (WHO), guidelines in respect to bacteria and toxic parameters. Other parameters are compared to EEC, US and Canadian standards. Morocco's National Office of Potable Water (ONEP) undertake water quality monitoring ranging from parasitological, planktonic and bacteriological examinations, to the determination of trace metals, pesticides, global radioactivity and toxicity tests (Abouzaid and Echihabi, 1995). These tests have shown higher than acceptable levels of pollution present in Morocco. As a result a request for local considerations to be taken in to account have dictated that the value of the maximum acceptable level for the total dissolved solids in water be increased to 2000 mg/l, rather than the generally accepted 1500 mg/l (Abouzaid and Echihabi, 1995). However, information on the effects of toxins, on animals and in particular on humans, in Africa, specifically Morocco remains scarce (Biney *et al.,* 1994). What we do know about Morocco is generally based on site-specific studies (Moubarrad and Assobhei, 2007). For example, research on toxin levels in fish and plants showed that shellfish had higher concentrations of heavy metals than finfish and inland plants possessed greater concentrations of heavy metals than coastal plants (Biney *et al.,* 1994). This seems a logical result in view of the lack of water movement due to the dry and arid climate

and lack of flowing water. Water quality appears not to improve regardless of the supply being within an urban or rural location.

Water quality assessment in the large cities of Morocco including Fez, based on physicochemical and ecotoxicological investigations, showed that the major water quality problems are: low dissolved oxygen (DO), high turbidity, organic matter and ammonia contents, severe chromium and copper pollution and high acute and chronic toxicity (Koukal *et al.,* 2004). As a result there has been a loss of aquatic life in the Fez River which continues to show significant acute and chronic toxicity (Koukal *et al.,* 2004). Well water in the region of Fez is of poor water quality with nitrate and metal enrichments resulting in both drinking water and water used for agricultural purposes, irrigation and watering cattle and sheep, represent a health risk to the population (Koukal *et al.,* 2004).

Waste water in El Jadida (Figure 6) has already had a negative impact on the environment and on human health (Moubarrad and Assobhei, 2007). Not least of concern is the colonisation of pathogenic species such as helminths and amoeba in Moroccan rivers apparently from waste water. Both Helminth and Ascaris eggs (Moubarrad and Assobhei, 2007), and pathogenic amoebae (*Acanthamoeba spp)* were reported to be present in the water all year round (Lorenzo-Morales *et al.,* 2007). It is not only waste water and rivers that are affected but also reservoirs which residents are reliant upon for drinking water. For example, microcystins were isolated from an extract of a cyanobacteria natural bloom, collected from a eutrophic Moroccan reservoir at Lalla Takerkoust, Marrakesh (Oudra *et al.,* 2001). Results showed that the

presence of cyanobacteria toxins in water used for drinking in Morocco may be regarded as a health hazard (Oudra *et al.*, 2001).

Figure 6. The location of El-Jadida, Morocco, where waste water has been reported to have had a negative impact on the environment and on human health.

Water quality in rural areas of Morocco is of no higher quality. Raw wastewater used for agricultural purposes has been shown to present health hazards in Morocco, particularly in regard to the transmission of geohelminthic infections in the area of Beni-Mellal, Morocco (Habbari *et al.*, 2000). Using wastewater to irrigate land increased infections with Ascariasis (Habbari *et al.*, 2000). Infections were reported to be five times higher among children in wastewater-impacted regions compared to overseas control regions which had suitable wastewater processing facilities. Contact with wastewater and wastewater irrigated land as well as reservoirs used as a general

public water supply were found to be associated with higher infection rates (Habbari *et al.,* 2000).

Both urban and rural water supplies have parasitic and bacterial colonies. This presents a cause for concern in regard to worldwide studies completed by WHO. WHO statistics (http://www.who.int), state that parasites are the cause of more human deaths than anything else with the exception of HIV/AIDS and TB. Parasitic infestations infects one-third of the worlds population, and are responsible for two to three million deaths per annum (Hirst and Stapley, 2000). Unsanitary water is thought to be a contributing factor in infection rates (Hirst and Stapley, 2000). With regard to TB in Morocco, spreading of the disease remains uncontrolled with various strains now being shown to be drug resistant (Tazi *et al.,* 2007). In particular, the strain *Mycobacteria tuberculosis,* which has been shown to be highly infectious and be predominately spread via contact with family members (P=0.006). Between TB, diabetes and parasitic infestations the outlook does not look good for Moroccan health. One of the most prevalent parasitic diseases is Schistosomiasis.

5.6 The affect of pollutants on parasitic and bacterial infection rates

Schistosomiasis is also known as bilharzia, swimmers itch and snail fever. It is a common parasitic disease affecting people in developing countries. It can cause a chronic illness via the infection of blood by the parasitic flatworm, or schistosome, which may result in liver and intestinal damage. It is most commonly found in Asia,

Africa, and South America, especially in areas with water that is contaminated with freshwater snails, which contain the parasite. It is also reported to occur in water of poor quality. Schistosomiasis is thought to have been prevalent in Morocco for centuries (Laamrani *et al.,* 2000).

Over the last three decades, the development of irrigation of sugar cane has led to the spread of the disease throughout Morocco, particularly in the Tessaout, Amont and Akka regions where oasis irrigation schemes are used (Laamrani *et al.,* 2000). In 1983 a programme was initiated in order to detect and treat contaminated water supplies by controlling snails (*Bulinus truncates)* using 30 molluscicide chemicals (Lahlou *et al.,* 2001). Rather than alleviating the problems, this treatment actually added to the problem, in that ground water became contaminated with the chemicals which were supposed to assist with producing better water quality (Laamrani *et al.,* 2000a, 2000b). As a result, water quality did not improve and crops continued to be irrigated with polluted water, as well as farm animals being supplied with contaminated drinking water.

Between 1984 and 1985 mean annual lamb mortalities were reported throughout the rural areas of Morocco. The data showed that lamb mortalities were due to bacterial infection as a result of either a lack of drinking water and food or access to drinking water of poor quality. Where starvation and exposure contributed most to lamb mortality (31.3%), enteritis and septicaemia represented the second most important cause (Chaarani *et al.,* 1991). Of the enteritis cases, 63.2% of the samples analysed were positive for *Escherichia coli*: of which 38.5% where septicaemia related cases. Of the 220 cases examined, 18.8% were also positive for *Pasturella hemolytica* and

25% were positive for *Pasturella multocida.* Research indicates that the high incidence of lamb mortality in Morocco can be reduced by improvement of nutrition and health care which includes access to clean drinking water (Chaarani *et al.,* 1991).

Moroccan authorities attempted to address issues with regard the quality of water, including drinking water, by adding fluoride (Tahaikt *et al.,* 2004). However, as was the case with the chemicals added to water in order to control snail populations, fluoride was also subsequently found to be at concentrations in drinking water which were detrimental to health with groundwater content exceeding 5 mg/l (Tahaikt *et al.,* 2004). Electrodialisis was then used in order to reduce not only the fluoride content of water but also other chemicals as well as the high nitrate content of Morocco's ground water (Tahaikt *et al.,* 2004; Menkouchi *et al.,* 2004). Without intervention Morocco's water supply will remain a health risk. It is not only parasitic and bacterial content which is of concern but also the physiological effects of consuming contaminated or polluted water. In addition, concerns in relation to consuming meat from cattle or sheep that have been raised drinking the contaminated water. There may be changes in reproductive fitness as a result of poor overall nutrition including poor quality water, particularly where heavy metals were present. Heavy metals have been shown to pass between species when one species eats the other. For example, waste water from local sugar industries which was shown to be responsible for contaminating drinking water, was used as drinking water for cattle, subsequently resulting in high metal contents in the meat that was meant for human consumption (Abou-Arba, 2001). These issues have also been identified and reported in other affluent countries, for example, eastern Australian soils are contaminated with heavy metals (Rayment *et al.,* 2002) as well as aconitic acid, a by-product of sugar cane

juice (Hanine *et al.,* 1992). Even in the Everglades, Southern Florida, a wealthy area of the United States, drainage water from the sugar industry has been found to contain high levels of phosphorous (Coale *et al.,* 1994a) as well as the heavy metals Cd, Hg, Pb, Cu and Zn (Rayment *et al.,* 2002). The run off from sugar mills is not the only issue in environmental health but also these heavy metals and various by-products which need to be disposed off.

5.7 Heavy metals in the environment

Heavy metals have long been associated with health issues (Goyer and Clarkson, 2001), in particular they have been shown to impair overall brain function (Grandjean, 1998). Even those metals associated with healthy bodies and physiological systems, in that, they are required as cofactors for enzymes, are toxic if present at high concentrations (FDA, 2001; Olalla *et al.,* 2004). For example Cu concentrations above 1.5-3mg/day has been shown to cause liver damage (FDA, 2001). Zn in concentrations higher than 12-15mg/day has been shown to reduce immune function (FDA, 2001). Cd is reported to cause kidney failure and effect reproductively (FDA, 2001), damage DNA in humans (Fatur *et al.,* 2002), and affect liver and blood cells (Cavas *et al.,* 1998; Tressou *et al.,* 2004).

Lead has been shown to have an adverse effect on health, specifically associated with immune alterations, even when present in what are considered acceptable and safe concentrations, that is, below 10 microg/dl (Dietert and Piepenbrink, 2006). Even at levels below this lead has been shown to induce cancers, renal tumours, increase

blood pressure, reduce cognitive development and increase cardiovascular disease (Goyer and Clarkson, 2001; Haider *et al.,* 2004; Ikem and Egiebor, 2005). Lead is known to impact physiological systems including reproductive, neurological, hepatic, renal and immune systems (Dietert and Piepenbrink, 2006). Unfortunately it is not only the environment which posses a significant health problem in Morocco. Lead and heavy metals are not only present in water, food and air but also in the traditional and cultural cosmetics that are used by Moroccan women, particularly at festive times, such as a birth or marriage.

Although there is also a lack of information specific to Morocco in regard to levels of contaminants in insects, animals and plants, there are reports which show high lead concentrations in henna and kohl. Henna is used as a traditional cosmetic, especially during weddings or festivities, particularly amongst women, children and babies and has religious associations (Lekouch *et al.,* 2001). Studies have shown that henna contains high levels of heavy metals and the more it is mixed with other herbs and colorants (elaborate henna), the concentrations increased (Lekouch *et al.,* 2001). (Lekouch *et al.,* 2001). Lead based kohl is commonly used in traditional cosmetics and in remedies in Morocco (Lekouch *et al.,* 2001). Kohl is considered to be a dangerous eye cosmetic. It is usually mixed applied on women's eyebrows and used in skin treatments for infants (Lekouch *et al.,* 2001). Lead concentrations in kohl were high but unlike henna, were lower when mixed with other products which appear to dilute the concentration of lead. However, both kohl and henna have been shown to contain high levels of lead and subsequently represent a health risk particularly for women and children (Lekouch *et al.,* 2001).

It is possible to determine other possible issues in Morocco by looking at the results of toxicology studies from other countries and the problems which exist there. Worldwide, heavy metals have been shown to affect a wide variety of animals and insects and the presence of heavy metals within the tissue of one animal has been shown to pass from one species to another via contaminated food or prey (Patrick and Loutit, 1978). For example, Cr, Cu, Mn, Fe and Zn can be concentrated in worms after digesting metal-enriched heterotrophic bacteria (Patrick and Louitit, 1978). The worms were then eaten by fish which subsequently showed high levels of heavy metal concentrations (Patrick and Loutit, 1978). Frogs, with high levels of heavy metals in their skin and muscle tissue have also been shown to pass on heavy metals. The frogs lay their eggs, which then develop into tadpoles which birds eat, thus passing the toxicity on to the bird (Burger and Snodgrass, 2001).

A study in Finland showed that numbers of the red wood ant *(Formica aquilonia)*, decreased by 34% in areas polluted with heavy metals (Eeva *et al.,* 2004). The change in colony size could not be explained by natural habitat differences (Eeva *et al.,* 2004). The heavy metal levels in *F. aquilonia* workers were high in concentrations of Ni, Pb and Cu (Eeva *et al.,* 2004). Smaller colony sizes indicated that pollution had a detrimental effect on reproduction (Eeva *et al.,* 2004). Tropical marine fish showed elevated levels of Fe, Zn and Cu, particularly within skin but also in their muscle tissue which had a positive correlation with regard a decrease in reproductive output (Singh *et al.,* 1991; Wirth *et al.,* 2005). Pollution stress appears to result in a trade-off in regard to reproduction, especially where there are high levels of Cu, Ni and Pb (Eeva *et al.,* 2004). This appears to be the case in fish and ants and could possibly be the case with larger animals such as cattle and sheep.

The content of heavy metals in food meant for human consumption has been identified as a global problem (Almela *et al.,* 2002). Some vegetables, for example, actually accumulate toxins which are then passed on to humans who eat them (Yusuf *et al.,* 2003). This has been identified as a major problem in Nigeria where a local staple crop, bush okra (*Corchorus olitorus)* accumulates Cd, Cu and Ni (Yusuf *et al.,* 2003). In the U.S.A, fish including mackerel, herring, salmon and tuna, sold in local markets have been shown to contain high levels of heavy metals (Ikem and Egiebor, 2005). Blood tests have verified that fish with high levels of heavy metals result in high levels of heavy metals in humans who consume them (Wirth *et al.,* 2005).

Food samples taken at food markets in Spain (Bordajani *et al.,* 2004), and Egypt showed that fruit and vegetable, including strawberries, cucumbers, dates and spinach had high levels of Pb, Cd, Cu and Zn (Radwan and Salama, 2006). Malaysian fruit and vegetables have also been reported to contain high levels of Cd and Pb (Sherif *et al.,* 2007). Cadmium and lead have both been shown to have a cyto-toxic effect which can be made more toxic with the presence of high levels of salt (Sharif *et al.,* 2007). Cauliflower, spinach and radish in India have been shown to have high levels of heavy metals (Patra *et al.,* 2001). In Mexico, it is not only meat, fruit and vegetables which have high levels of lead but also local traditional medicines and remedies used to treat gastrointestinal infections (Haider *et al.,* 2004). It is not just food which is affected. Traditional Tunisian earthenware made from local clay and used to cook and store food has also been shown to contain high levels of toxic heavy metals (Belgaied, 2003). These issues are relevant to Morocco, in that Moroccans have a diet high in fruit and vegetables which are often picked and eaten straight from the plant, as well

as having cattle raised on poor quality water and where the meat is cooked in earthenware which is still traditionally made and used to store and cook food as in neighbouring Tunisia. The issue of herbicides is also of concern.

6. The problem of by-products and waste and possible remediation methods

Molasses causes a significant pollution problem worldwide, in both poor countries and those more affluent, for example, in Kenya (Ouma-Onyango, 1997) and America (Reddy, 2007). America produces tonnes of molasses that cannot be exported due to government restrictions (Reddy, 2007), they therefore dump it in pits which lead to pollution problems, in particular within the Indian state of Karnataka (Reddy, 2007). The problem is further enhanced due to the lowered price of molasses which is now sold from India at 250 rupees a tonne compared to last years price of 5000 Rupees. There are presently 45 sugar factories in Karnataka, all of which are at their storage capacity to hold molasses, leaving them no other alternative but to dump it in unofficial pits in the surrounding residential area (Reddy, 2007). Distilleries in Goa operate the same way, openly dumping molasses on open ground in neighbouring India (The Hindu, 2005). Molasses dumps are reported to be particularly prevalent in Bangledesh (Rasul *et al.,* 2006). Asia also dumped molasses in pits until the passing of legislation in Thailand in June 1992 when Thailand's National Environmental

Protection Act was introduced (Cheesman, 2004). However, damage to the environment in the form of soil erosion, loss of natural habitats, run off and leachate pollution has already had a significant impact (Cheesman, 2004).

The environmental impacts of the effect of molasses polluting water ways have been well documented. Molasses dumping has been responsible for polluting more than 600 km of rivers in North Thailand and as a result has devastated fishery stocks and water supplies (Hunt, 1992). Colonising bacteria consumed all the oxygen in the water and suffocated local fish stocks and freshwater animals (Graf *et al.,* 1996; Laws, 2000). An example was made of the Khon Khaen sugar mill which was closed due to continuous aquatic pollution due to molasses dumping (Laws, 2000). A massive fish kill over 30 km was reported in 1998 in Ingenio, Canada as a result of thousands of tonnes of molasses being spilled in to the local water bodies. The river is still reported to be devoid of any fish life as a result (Graf *et al.,* 1996). In Kenya and Nairobi, which share the Athi tributaries, pollutants from sugar cane industries have been carried towards the Indian Ocean. Industrial effluent has been found in fish stocks dozens of km away (Opala, 2001). Sections of the tributaries are, according to the World Health Organisation (WHO), 2000 times more polluted than recommended WHO guidelines (Opala, 2000).

6.1 Uses for molasses, bagasse, filter cake and fibre

It is possible to obtain numerous useful by-products from the processing of sugar which can be used as raw materials for the extractive, chemical and biochemical

industry (Almazan *et al.,* 1998). Overall, the world's sugar producing countries currently produce more than fifty commercial products from sugar cane by-products (Almazan *et al.,* 1998). One hectare of cane may produce 100 tonnes of green matter every year, which is more than twice the agricultural yield of most other commercial crops (Almazan *et al.,* 1998). Its total dry matter content has a fuel equivalent of about 10 to 20 tonnes of oil. In relation to animal feed, each cultivated hectare delivers 75 000 million calories each year, equivalent to more than 8 times the yield of other fodder crops (Almazan *et al.,* 1998).

Molasses can be used as cattle food, syrup used to flavour rum, an additive for ethyl alcohol or processed tobaccos (Harris and Staples, 1998). It contains sugar, nitrogen and minerals which can be used to encourage the biological degradation of TNT and its derivatives (Widrig *et al.,* 1997). Sugar cane mills in the Philippines discovered that by-products, including molasses could be used as an agricultural fertiliser, an irrigation resource and used for cleaning up factory spills (Manalili *et al.,* 2003). Using molasses as a fertiliser reduced pollution clean-up costs due to reduced dumping of waste, increased crop yields and at the same time reduced the need for the purchase of expensive fertilisers (Manalili *et al.,* 2003). However, molasses need to be used in limited quantities in order that it does not become toxic. Clean up costs related to molasses dumping equated to 2039US$ per hectare, which reduced to 987US$ per hectare when recycling molasses as an agricultural fertiliser (Manalili *et al.,* 2003). Molasses has been proven to be a good fertiliser when used in small quantities but can equally act as a poison if used in excess (Opala, 2001). One time applications of molasses has been shown to boost microbial soil populations which then decompose the ligno-cellulosic components (Boopathy *et al.,* 2007).

London Distilleries Kenya Ltd, use molasses to manufacture alcoholic beverages (Opala, 2001) reducing their need to dump molasses in local pits. However, London Distilleries cannot control their molasses overspill which continues to discharge in to the Nairobi, Ngong and Mathare tributaries (Opala, 2001). Of the 75 sugar mills in Pakistan, seven convert molasses into industrial alcohol **(**Anonymous, 2003? Environmental Technology Program for Industry, 2003). A niche market may also exist in the sustainable agricultural systems in the tropics which require alternatives for nitrogen fertilisers that currently represent a major source of groundwater and air pollution (Dobereiner *et al.,* 1995). Molasses may be able to fill this requirement.

Molasses has also been used to clean-up contaminated ground water that resulted after three decades of industrial plant pollution dumping in the affluent area of Silicon Valley (Simonson, 2006). The dumping of pollutants, molasses, solvents, paint thinners and anti-freeze, effected wildlife, especially in the East Palo Alto area which also represents the most poor and ethnically diverse community in the region with little economic stability and no monetary resources to spend on cleaning up the environment (Simonson, 2006). The polluted areas were treated in-situ using bacteria to break down solvents into CO^2 and H_2O (Simonson, 2006). In the first year of treatment it was estimated that the area was 99% clean (Simpson, 2006).

Under tropical conditions, sugar cane has been used as a source of up to 60 – 80% fodder for ruminant and swine feeding requirements, but has been proven to be an inadequate food unless supplemented with other products, such as grain (Almazan *et al.,* 1998). Sugar cane is now recognised as being suitable as animal feed in three

basic components. Crop waste in its natural form for feeding bovines, the soluble sugars present in the juice for poultry and swine, and fibre, for ruminants (Almazan *et al.,* 1998). The highest conversion of energy was accomplished in the production of swine and cow milk (Almazan *et al.,* 1998). As shown in the previous section in relation to feeding molasses to Moroccan cattle, in the case of protein conversion, meat production through bovines was shown to be the least efficient (Almazan *et al.,* 1998). Cuba has one of the largest numbers of technologies for manufacture of by-products, and has developed molasses as cattle fodder, although finding that feeds needed to be supplemented with molasses but again molasses was shown to be an incomplete substitute for grain (AMAS, 1998). However, this was not known in Morocco. It was during the 1940s that experimentation began, in Morocco, in order to determine the suitability of molasses as an alternative source of fodder (Araba *et al.,* 1997). However, the true focus was not on producing self-sufficient Morocco, but rather on profit and economic gain for Western countries.

The underlying use of molasses as cattle fodder was primarily price factors. Molasses are inexpensive to produce, has a low energy input, and does not compete with food produced for human consumption. Molasses used as cattle fodder would subsequently reduce the need to import grain and therefore reduce the cost of subsidises by neighbouring countries. Using molasses also decreased land utilization and the requirement for machinery and irrigation as grain was no longer grown to the extent previously (Araba *et al.,* 1997). Other saving relate to costs including transport, taxes, irrigation, all of which eased expenses for associated countries.

According to France, United States of America and Scandinavian countries, replacing grain feed with sugar beet or sugar cane by-products reduces the requirement for land for crop production for cattle diets. They argued that molasses as fodder had no detrimental effects on cattle and yet reduced the assistance required by these countries as well as resulting, in theory, in more food for human consumption (Araba *et al.*, 1997). If it was financially, economically and nutritionally beneficial why did these countries not employ this method themselves? None of the countries wishing to implement the idea of feeding molasses to cattle in Morocco use only sugar by-products to feed their own cattle. Further investigation reveals a probable reason for this. Molasses was actually used to feed cattle in other countries, but was generally subsidised with grain. A diet based solely on molasses is not deemed to be adequate nutrition for animals.

In experiments overseen by Europe, sugar beet molasses were fed to 100 000 cattle in Morocco. The bulls were slaughtered in order to determine fat content, weight gain, and carcass compactness after being fed molasses. These factors were then compared to grain-fed cattle. The experiment concluded that a saving of 47 - 76% of barley crops was made in molasses fed-cattle. It was then argued that this was of benefit as it resulted in meeting the high demand for meat in Morocco whilst at the same time being a 'friendlier meat protein production system' (Araba *et al.*, 1997). With the devastation of the forests to fuel the sugar industry, it may be argued that a token environmental benefit such as production of more meat without overgrazing made Europe seemly sympathetic to the environment and at the same time presented them as allies rather than tyrants.

The actual detrimental sides of the experiment were not advertised in Morocco. A diet of molasses refined from sugar beet was found to decrease animal performance, and a molasses diet of 60% increased cattle bloat. Overall there was no more an actual increase in beef production by feeding molasses to cattle than if the cattle had been fed grain (Araba *et al.,* 1997). In reality the meat was of a significant lower quality. This seems to have been awarded very little importance with the emphasis being on the use of molasses being cheaper and easier to obtain for Moroccan cattle thus reducing costs and grain imports to Morocco. This would aid overseas economies which were then able to sell their grain to other countries for greater profit due to higher prices over seas. This also meant that the national debt of Morocco was not increasing due to more grain imports. Overall, the benefits of molasses as cattle fodder were complex and more related to profits in other nations than to the nutritional requirements of Moroccans.

In response to these studies, and in order to meet the requirement for molasses, both sugar beet and sugar cane started to be produced. In the mid 1900s approximately 100-180 tonnes of molasses were produced, of which one third was exported at a low price (Araba *et al.,* 1997). However, it was quickly determined by locals that grain was still required as a substitute feed. Almost simultaneously with this revelation the price of import grain increased and became expensive relative to the value gained from the export of low priced molasses. Subsequently meat costs increased in Morocco due to the increasing expense of imported feed (Araba *et al.,* 1997). The economy overseas was winning in all directions with the import of their expensive feed and the purchasing power of low priced molasses. The purchasing power of ordinary Moroccan nationals declined.

The adverse consequences of by-product resource utilization were not fully considered for Morocco. Such consequences would have been major considerations in European countries. The sugar mills re-employed to produce molasses not only resulted in meat with high contents of sugar but also resulted in by-products which further damaged the environment. The European intervention to feed the now rapidly growing Moroccan population suddenly became a failure, yet this was not immediately recognised by the indigenous people. In addition chemical by-products of molasses production continued to result in sediment loads and chemical residues as well as heavy pollutants that have an adverse impact on water quality and the general environment (outlined further in a later section). These were not collected or disposed of safely but were poured out into the environment: into rivers, fields, surrounding valleys and the surrounding oceans (Ogolla and Bondi. 1989). The helping hand of Europe turned a blind eye whilst gaining large economic benefits.

There were obvious reasons why research into molasses as a fodder for cattle was undertaken by foreigners in Morocco and did not extend to include Moroccan national scientists, but this also seems to be the case with much research today. Other nations appear to lack conscience when utilizing Moroccan resources. Compensation is not paid for damage as would be required in their own country. Studies which were undertaken on molasses as fodder for cattle as well as other present day studies all use Moroccan resources, are subject to few regulations and have low costs. For example, current studies on lipase production by France, Canada and the USA employ Rabat's, internationally renowned Moroccan laboratory, but employ scientists and staff from their own country. This results in either wealthy (relative to most Moroccans) foreign

staff and/or the higher social classes from France carrying out studies that would require extensive permits and ethical consideration in their home country (Legrouri *et al.,* 2004).

Once such research has been completed, foreigners return home whilst the detrimental effects continue in Morocco, not only for humans, animals and the environment but also in plants. A plant disease called 'decline' which is the gradual reduction of growth and general plant vigour, results from human activity on land and has associated pathogens, chemicals and results in an acidic environment which can persist for generations (Pitelka and Dudley, 1989). Much of the damage caused can be argued to have reached such a level that no amount of reparation could return the land to it's formerly fertility. The deforestation and desertification of Morocco's valleys is difficult to remedy in a country where the focus is on feeding the family and simply surviving. Sugar is no longer considered the main fodder for cattle but is still a significant by-product of Morocco.

Three hundred thousand tonnes of sugar cane bagasse, which is the fibre left over after the juice has been squeezed out of sugarcane stalks, is produced per annum in Morocco of which 80-85% is used as fuel (Cordova, 1998). Bagasse obtained as a by-product of sugar cane processing, is composed of fibre, pith, non-soluble solids and water (Almazan *et al.,* 1998). Fibre represents about half of all components, and includes cellulose, hemicelluloses and lignin (Almazan *et al.,* 1998). Bagasse can be dried and used as fuel (Harris and Staples, 1998). Every year, more than 200 million tonnes of bagasse are produced, 95% of which is used as fuel in sugar mills, representing a saving of about 40 million tonnes of oil (Almazan *et al.,* 1998). The

bagasse not used as fuel can be used as pulp and paper, boards and animal feed (Almazan *et al.,* 1998).

One hectare of sugar cane can produce, annually, about five tonnes of fibre for pulp and paper production, twice as much as that produced by one hectare of wood, dependant on factors such as age and quality, with the same management and about fifteen times shorter in regard to renewal (Almazan *et al.,* 1998). As well as a use as fuel, sugar cane bagasse after burning produces silicon and aluminium oxides which have been shown to be useful as a cement replacing material in the concrete industry (Paya *et al.,* 2002). Bagasse is used in the Philippines as a natural absorber of grease and oil which has reduced water usage in cleaning as well as effluent production (Rouilland, 1990). Water use as a result decreased from 18000m3 per day to 1500m3 per day which subsequently had the effect of improving the quality of water in local rivers so they now conform to local government water quality standards (Rouilland, 1990).

Thailand produces on average, two million tonnes of filter cake waste containing 1.8% nitrogen (Meunchang *et al.,* 2005). Filter cake alone and filter cake mixed with bagasse were investigated as potential fertilisers. Both mixes were found to have a thermophillic stage lasting 15-20 days (Meunchang *et al.,* 2005). Organic matter degraded over 40 days and reached a stable C/N, low NH^4/NO^{3-} level and lack of heat production at approximately 90 days (Meunchang *et al.,* 2005). Although both mixes showed potential to be used as fertilisers, the filter-cake bagasse mix appeared to assist nitrogen conservation slightly better than the pure filter cake mix (Meunchang

et al., 2005). Both have the potential to reduce the need for nitrogen based fertilisers and subsequently nutrient run-off.

Research has been investigating ways to recover carboxylic acids in order to reduce environmental pollution and to find ways to recycle the by-product aconitic acid which can be used in food-processing and chemical industries (Malmary *et al.,* 1995). Lignin is the second most abundant substance in nature, and at the same time one of the least exploited up to the present (Almazan *et al.,* 1998). A great potential exists for its use in the chemical industry. It is technologically feasible to obtain phenols for production of adhesives, resins, fungicides, veterinary products, insecticides, and carbon (Almazan *et al.,* 1998). Lignin and cellulose are major components of waste substrates and their disposal is an environmental problem, but it appears that sugar cane waste products are an inexpensive fermentation media for the production of useful compounds (El-Nasser *et al.,* 1997).

6.2 Waste minimisation and possible bioremediation techniques

With the environmental impacts of the sugar industry becoming clearer, and uses for many of the by-products being realised, many sugar industries are making a move towards green cane sugar production systems (Meyers *et al.,* 2005; Sampietro and Vattuone, 2006). In Karachi, Pakistan, sugar mills have been researching how to best re-use waste water by investigating methods of pollutant removal which would allow the water to be recycled for use in irrigation (Rouilland, 1990). A factory in New

South Wales, Australia has now employed a system of water recycling (Lamb, 2001). In New South Wales, Australia, the sugar mill industry has gone much further, in that it has been recognised as being an outstanding achiever in waste minimisation in that they produce practically no production waste (Lamb, 2001). Waste fibre is used to fuel boilers, water used in cleaning the mill is recycled, steam is used to run the plant instead of coal, and a power system has been incorporated which results in the factory being able to export power to the national grid at an average of 4MW per season (Lamb, 2001). The factory makes significant savings in regard to reduced waste disposal, energy consumption and payments which would be due relative to carbon emissions (Lamb, 2001). Other countries have also made progress, for example, Brazil today has the lowest use of nitrogen fertiliser use in relation to phosphate (Dobereiner *et al.,* 1995).

A traditional sugar cane factory is inefficient in the use of energy in its bagasse but it has been shown that with a properly designed process, oriented to energy saving, it is possible to operate with only 50 percent of that energy (Almazan *et al.,* 1998). Sugar cane processed using chemical and biotechnologies, has been shown to produce a high number of products, which is surpassed only by those obtained from petrochemistry industry (Almazan *et al.,* 1998). Sugar cane by-products have the advantage in being a renewable raw material, which can be used in human and animal feeding, and in the production of basic chemicals, with a yield not equalled by any other plant (Almazan *et al.,* 1998). Furthermore, sugar cane has energy delivering capacity equivalent to five times that used by the crop.

Amongst commercial crops, sugar cane is argued to possess a high photosynthetic capability, allowing it a high coefficient of CO_2 fixation. This has been argued to cause a decrease in the greenhouse effect (Almazan *et al.,* 1998). However, this needs to take in to account the use of fossil fuels in order to run mills, burning practices, fertiliser and herbicide production and application as well as transportation of products to the mills and the finished products to market and export. Even if taking into account the many uses of the by-products of sugar cane production, and reports which indicate a decrease in greenhouse gas production, overall carbon production may be at best, carbon neutral, and at worst lead to increased greenhouse gases in the atmosphere.

With many of the world's poorer countries now suffering pollution of soils and rivers and having no financial resources to pay for cleaning up the damage, researchers have been seeking ways to rectify the problems with minimal cost. This has included scientific methods such as bimolecular engineering, and the bioremediation of persistent organic pollutants (POPs) using genetically modified micro-organisms which can assist in environmental protection (Ang *et al.,* 2005). It is reported that bio molecular engineering techniques has created the potential to remediate some of the most recalcitrant and hazardous compounds in the environment (Ang *et al.,* 2005). Enzymatic hydrolysis of bagasse in one such method that has been investigated (Zheng *et al.,* 2002). Bioremediation is cost-effective and has the ability to achieve complete degradation of organic pollutants without further destruction of the site or its indigenous flora and fauna (Ang *et al.,* 2005). However, the ability of indigenous micro-organisms at contaminated sites to biodegrade pollutants may not evolve for many generations if reliant on random mutation (Ang *et al.,* 2005). This is particularly

true where there may be multiple biodegradation traits required as would be the case with sites contaminated with more than one organic compound or by-product from sugar cane processing methods. Sugar cane production techniques have brought about widespread pollution of the natural environment and resulted in many organic pollutants, herbicides and pesticides which may be resistant to degradation and thus represent an ongoing toxicological threat to both wildlife and human beings (Ang *et al.,* 2005). For countries which may lack funding for bioremediation research, especially the manipulation of native microbes for use in bioremediation methods, they may be best focused on existing species which are readily accessible.

Sugar cane by-products contain ligno-cellulosic material which can be used as a substrate for the purpose of bioconversion by the fungus *Humicola grisea var. thermoidea* (de-Paulo *et al.,* 1999). *H. var. thermoidea* has been shown to be useful in the bioconversion of sugar cane bagasse to soluble carbon (de-Paula *et al.,* 1999). In addition, three different strains of white rot fungi, *Phanerochaete chrysosporium NRRL 6359, P. chrysosporium NRRL 6361* and *Coriolus versicolor NRRL 6102,* were found to be able to biodegrade agricultural waste, in particular treated sugar cane (El-Nasser *et al.,* 1997). Other micro-organisms have indicated good absorption efficiency for tannic acid and melanoidins which represent a large source of aqueous pollution from sugar cane industries (Figaro, 2006). Hawaii sugar cane mills found that treating waste water using anaerobic and aerobic treatments removed pollutants from water which then allowed for the water to be re-used for irrigation (Yang *et al.,* 1991). Similar results were found using bacteria, in particular bacteria-yeast hybrids (Kosba *et al.,* 1999). *Bacillus spp; Bacillus polymyxa* and *Bacillus licheniformis* removed 50% of nitrates from sugar cane waste by-products (Kosba *et al.,* 1999). In

Sao Paulo, Brazil spent mash and waste water is now digested using anaerobic bacteria resulting in the subsequent reduction in BODs produced from cane washing which was further assisted by using aerated lagoons containing *Saccharomyces spp* (Monteiro, 1975).

7. Discussion of the sugar culture in Morocco and anthropological theory

Mintz's (2005) theory in explaining the importance of food in its symbolic form allowing communication and revelation about individual and group identities appears to be upheld in relation to Berber societies and their specific use of sugar. Berber communities hold sugar in high regard, not only as a luxury commodity made ever more relevant by the labour and time required for its production, but also because sugar can act as a social marker and a symbol from which is made clear certain intentions. Sugar could be argued to have an irreplaceable importance in both a cultural and traditional sense which still holds true in modern day Morocco.

Sugar undoubtedly exerts power within Berber communities in the form of relationships on a personal scale between one individual and another as well as within the extended Berber community. The value of sugar can be attributed not only to labour, time and energy in its cultivation and production but more importantly in the traditional Berber methods employed to discern a pure product worthy of presentation as a gift to secure a wife. In addition sugar exerts power within society as a whole and

is responsible for driving many traditional and cultural events, as well as enforcing the acceptability of certain attained quality in which is reflected and upheld specific symbolisms and meanings that are relatively more masked in Western society. The idea of sugar representing 'goodness' and 'purity' is upheld with regard to both Berber marriage and birth, and as a commodity of power is linked to local and global controls at both national and international levels, yet exerts the most power over individual life events.

Sugar exerts both beneficial and fatalistic power over individuals, within family relationships and throughout whole communities. This research paper has displayed both subtle and obvious levels of power that sugar exerts over everyday life, special occasions and important life events such as birth and marriage. It is not only a luxury commodity but also a symbol and presents unspoken respect and thoughts.

Politically, economically and medically, Moroccan nationals are subjected to powers both subtle and blatant in the form of imports, exports, supply and demand, labour, political wars, agricultural and industrial advances, effects on environmental conditions, health and well-being. There also exist great inequalities both between countries with power over Morocco and outright power that even Moroccan authorities exert daily over decisions affecting the population in general. For example, decisions are made by Europe or America, not to compensate for environmental damage and also by local authorities not to treat Moroccans with serious illness. Sugar is intertwined in all these factors and yet has the potential to have positive effects on society.

The many faces of assistance and sympathy to Morocco, which on the surface appear to be beneficial to Morocco, actually undermine social structure whilst at the same time take as much advantage as can be gained. This is a position which seems to have persisted since the beginning of record keeping in the early 6th Century, yet is also fuelled and held in a secure place by local customs, traditions and beliefs resulting in a stable and conforming mass habitus.

As I showed earlier, sugar also serves as a bargaining commodity and as a supernatural protection against bad house spirits and serves Mintz's idea of the perception of sugar as 'good'. The opposing 'badness' of sugar as outlined in this document, reveals incalculable negative legacies resulting from international economics, politics, and greed which have a detrimental impact on a personal, community and social level, as well as economically, politically and environmentally. All three impacts have their roots in power exerted over Morocco by neighbouring countries.

It could be argued that both sugar and the teachings of folk law are directly related to diet and can therefore be argued to be very much intertwined and directly relevant to each other as well as to the changes that ensued in society after their introduction. It is the sheer desire for sugar, the addiction to it, and the importance attributed to it in relation to festivals and traditions that render it a powerful commodity at every level of society. This also makes it inseparable from life. This is fuelled by national beliefs and reinforced by Bourdieu's concept of habitus and Foucault's concept of normalization as well as making it clear that power is in fact everywhere in Moroccan society. Mintz has clearly shown the power associated with this commodity and the

power it exerts in every niche of life. This is kept in place by the accepted norms and beliefs within society which contribute to adherence to Bourdieu's concept of habitus and Foucault's concept of normalisation.

7.1 Cultural and traditional issues facing Berber communities in Morocco

The fact that Morocco still has a large population that is illiterate and the majority of village residents speaking only their tribal Berber language, and having absolute belief in traditions and the importance of culture leads to an educational dilemma. In the village of Rastabouda, the local language is known as Tamazight which is one of the Amazigh languages. It is estimated that only 400 individuals speak this dialect and many of these do not read or write and rely solely on verbal communication to pass on information. The fear of authority for many Moroccans, living within Morocco and abroad, encourages close-nit communities who rely on each other. As with early anthropologists, outsiders looking in at such a community may lack understanding of traditions and Berber culture. This is especially true in relation to death where Berbers residing overseas, for example in France, plan their death, in that they organise travel back to their village of birth rather than die in a foreign country. Even though it has been shown that medical treatment is more probable and comprehensive overseas, culture and tradition prevail. Moroccans travel back to their homeland in order to die, even when death is likely to be slow and medical assistance difficult if not impossible to obtain. In view of this, it is highly unlikely that Berber communities would change their cultural or traditional methods and beliefs. Even if resources were available in

regard to the prevention of diabetes, general communities often lack finance with many individuals living in abject poverty, both in cities and remote country villages. Sugar continues to represent an affordable and convenient foodstuff, but which is low in nutritional quality. These factors, along with the traditional, cultural and spiritual significance of sugar, indicate that it will remain a significant factor in Berber culture for generations to come, along with the proliferation of associated problems.

Although the direct health effects of consuming too much sugar, i.e. periodontal disease, and diabetes with all its complications, may be difficult to remedy in societies which are often wary of outsiders, rely on spoken language only and have tenacious cultural and traditional values, there may be more opportunities to remedy some of the environmental effects. Some direct and indirect impacts of the sugar industry, including herbicide poisoning, heavy metal presence in food, suffocation of fish, high sugar levels in meat, parasitic diseases and even TB, may be best addressed initially using some form of education awareness programme. The long lasting environmental effects could be remedied with international assistance, especially as the international need for sugar created much of today's pollution and toxicity. Bio-remediation may be an effective and cost appropriate step forward towards providing clean water to irrigate crops and drinking water for animals. This would go some way to restore river water, ground water and well water quality and subsequently the quality of fruit, vegetables and meat for human consumption. It would also reduce parasitic infestations, all without the need to encroach on the daily lives of locals.

7.2 The place of sugar in Moroccan society today

Every facet of daily Moroccan life is surrounded in some way by the presence of sugar or its effects. Good quality sugar continues to represent sweetness, purity and value in negotiations of marriage. Its place as a guardian over newborn babies, in that sugar serves as the protector against evil 'jnin' spirits, is a belief held by the Berber people in Rastabouda. Sugar is clearly interwoven in every aspect of Moroccan culture and tradition. Historically, sugar allowed Morocco to profit on the world market due to international demand and ensured ongoing employment. For a country with an arid and dry climate and where growing other agricultural crops failed, sugar continues to represent a food which provides a high calorific intake.

Conversely, sugar used as a gift to secure marriage may lead to a female committing suicide in order to avoid the union. Slavery, although slow to encroach on Morocco, finally led to men and women being taken overseas in order to work on sugar plantations. Many remaining individuals worked in sugar mills in Morocco with the primary aim of providing for the sugar demands of Europe and America. During harvesting, processing and refining not only did human health suffer but so did the environment, including land animals and aquatic life. The sugar industry itself had major environmental impacts with deforestation, water quality, soil quality and air pollution. The subsequent decline of the sugar industry, not only in Morocco but also in other countries, has reduced employment opportunities. Machinery and sugar mills were not dismantled and continue to decay. This causes environmental impacts such as increased leachate and heavy metal content in crops and animals as well as causing suffocation of fish stocks and other aquatic animals. At the close of Morocco's sugar

mills there was widespread unemployment and no attempt to clean up pollutants, the consequences of which have been discussed earlier.

Sugar led to what could be seen as an epidemic. Diabetes and tooth decay, as well as periodontal disease are common in both urban and rural Morocco, particularly within Berber communities. In recent decades, cattle being fed diets of molasses, which are not substituted with grain as in other countries, has subsequently lead to poor meat quality and meat with high levels of sugar. Nothing has been done to educate locals in respect to this.

8. Conclusion

Sidney Mintz's concept of power in relation to peasantry, slavery, and exploitation in regard to the sugar cane industry are as relevant to Morocco as they were to Puerto Rico (Mintz, 1959a, 1960, 1978, 1985a, 1985b, 1996a). In particular, his research on the history and meaning of food, anthropology of eating and his social-cultural analysis of sugar in Puerto Rico and African-America are equally applicable in Morocco (Mintz, 1978; Mintz and Price, 1992; Mintz and Du Bois, 2002). This also extends to Mintz's study on the effects of sugar plantations in the Caribbean in relation to consumer behaviour in Europe and the world economy (Mintz, 1985b, 1985c, 1996a). Furthermore, Mintz's concept that explaining the importance of food in its symbolic form allows communication and revelation about individual and group identities is particularly true in regard to Berber culture and tradition. Overall power has been proven to have been present in Morocco throughout the history of sugar, in

relation to employment, production, monetary gain, slavery and exploitation, as well as social relevance and providing a means by which to identify ones own culture and beliefs. Sugar is shown to be interwoven with Berber culture and Moroccan life and has relevance in many facets of daily life. Furthermore, the power attributed to sugar is interwoven with political and economic factors. The power and value of sugar is seen in its use to pacify a nation as was evident with exceptions to rationing in regard to sugar quantities assigned to Morocco during World War II. Sugar has a firm place within Moroccan society and is indelibly linked with all facets of life.

Bourdieu's belief that society cannot be analysed by looking at one factor alone, such as economic class or ideologies, but rather, other factors such as education and culture have also been upheld in Morocco (Bourdieu and Pesseron, 1990a). A field, as presented by Bourdieu, in Morocco, is represented by a system of social positions which are directly structured in terms of power relationships. This is especially the case in respect to the patriarchal systems in play within Morocco, particularly within Berber communities. In addition, in regard to Foucault's idea of struggling for gain, Morocco's sugar industry represented a struggle to ascertain capital gain, which was primarily a struggle related to monetary gain. This was particularly true in regard to the production and export of sugar as well as the import cost of grain and the subsequent decision to feed Moroccan cattle on a sole diet of molasses, thus increasing profits overseas and decreasing financial aid to Morocco in the form of substituted grain imports (Bourdieu and Pesseron, 1990). Fields are also clearly evident within Berber families, and wider Moroccan society. They are autonomous independent forms of social play which are not necessarily limited to monetary gain, but which also relate to cultural and symbolic gain, such as is the case with using

sugar as a bargaining tool in order to gain a wife (Bourdieu, 2005). As seen with tradition, fields can be complex and inter-related, as may be the case with links between suicide, marriage and sugar that are also linked with accepted norms and values within society (Ward, 2004).

Foucault's philosophy in respect to sexuality and power within relationships is also made clear in the tradition of negotiating marriage and enforcing a patriarchal society (Todd, 1955; Foucault, 1978). Morocco has a complex societal structure which is held in place by strongly held beliefs in relation to structures present in society. These structures lead to either constraint or enablement of an individual or community (Todd, 1955). Foucault's concept that power exhibits various forms of constraint on the actions of individuals, communities and society, but makes certain actions possible, although these may be limited, have been shown to be the case in regard to gender power, political and economic struggles in Morocco (Foucault, 1979). Furthermore, the actions of individuals have been shown to be based on inherent customs, traditions, culture and verbally communicated folk law. In addition, where there may appear to be alternative solutions to a particular situation, these may not be evident to an individual of Berber decent. In particular, where there may be a choice between marrying someone, committing suicide or running away. The latter two would be equally dishonorable and hence running away not be a real option, especially in view of limited resources, and lack of both sympathy within the culture and social welfare. Therefore, decisions are based on complex interactions of belief, habitus and economic factors.

The theories of Mintz, Bourdieu and Foucault which focus on mass compliance in relation to accepted norms and values in society are upheld in Morocco. It is accepted norms and values within Moroccan communities that exert power, control and compliance of the population. In addition to social power, there is power exerted by authorities both nationally and internationally especially in relation to power exhibited over the export and import of goods. This is also applicable to the environment.

Europe and America exercised power over Morocco, in encouraging its agricultural advancement for their own gain and in using Morocco ports for their own strategic military advantage. This included making full use of the resources and positioning of Morocco in relation to the war and sugar production. However, this was only the case whilst it was economically beneficial to do so. When this was no longer the case due to high fuel prices, sugar production was moved overseas in order to increase profitability. The environmental damage left behind as a result of the sugar industry, which once flourished in order to provide the West with sugar, remains extensive. In view of this it would not be unreasonable to expect some form of international assistance in regard to educational programs, medical assistance and environmental remediation. This may be a small price to pay in view of the profit and military strategic advantages that have been gained from Morocco throughout history. Such an act would go some way to contribute to better health for all Moroccans but especially those in rural areas who lack any opportunity to attend school or obtain medical care. The fact that diabetes and other health issues prevail in these areas, including bacterial infections from poor water quality and contaminated food and meat, are major issues which need addressing and have been left largely unattended. The fact that international water quality standards were decreased in Morocco in order to take into

account local conditions, does not mean that the issue of contamination and the affects on humans, crops or cattle are any less serious.

8.1 Future Research

It would be interesting to measure the impact that eating a diet high in sugar has on educational performance for communities living in Morocco, particularly the Berber communities which reside in rural and remote locations. This would need a mix of anthropological, sociological and scientific research in order to cater for differences in cultural learning styles, understanding of the nuances present between villages and tribes and which would allow for the collection of quantitative and qualitative data. As heavy metals have been shown to decrease cognitive ability and brain function, the educational capabilities of children living in high risk areas could be compared to those individuals of similar age and same gender living overseas, for example in France, in order to determine any effect on academic ability. Bioremediation methods using native species to facilitate the cleaning of rivers, reservoirs and wells could be investigated in order to provide cost efficient measures in removing heavy metal contamination. International co-operation and focus in regard to environmentally acceptable removal of sugar mills so that they do not continue to decay into the surrounding environment would be advisable, especially in view of the fact that the mills were initially built to supply the western world with sugar. Local education programs, possibly sponsored by international aid organizations, could be proposed in order that people be educated about the dangers of lead, in traditional cosmetics and within the environment. This could also be presented as a way to inform individuals

about parasitic diseases. More could be done to educate school children about the dangers of the spread of TB especially during contact with others and in particular when gifting sugar that may be communally shared. Recording specific dialects and languages within the Rif region and in other areas of Morocco would be valuable in helping to conserve the many Berber languages which are not written but are kept alive solely by verbal transmission.

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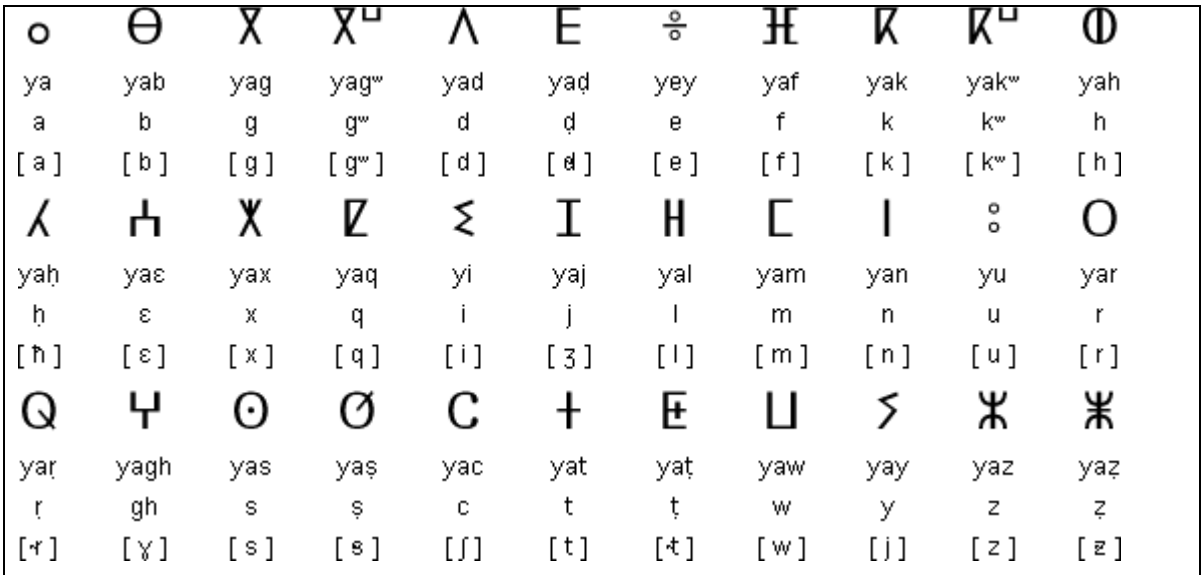
Appendix A



Sample text in Tamazight

ⵣⵎⴰⵏⵉⵏ, ⵓⴽⴽⵉ ⵎⴰ ⵍⵍⴰⵏ ⵜⵜⵍⴰⵍⵏ ⴷ ⵉⵍⵍⵉⵢⵢⵏ ⵎⵙⴰⵡⴰⵏ ⴷⵉ ⵍⵀⵡⵚⵎⴰ ⴷ ⵢⵉⵣⵔⴼⴰⵏ-ⵖⵓⵔ ⵙⵏ ⵜⴰⵎⵙⴰⴽⵡⵉⵜ ⴷ ⵍⴰⵇⵓⵍ ⵓ ⵢⵙⵙⴻⴼⴽ ⴰⴷ-ⵜⵉⵍⵉ ⵜⴻⴳⵎⴰⵜⵜ ⴳⴰⵔ ⴰⵙⵏ.

Transliteration

Imdanen, akken ma llan ttlalen d ilelliyen msawan di lḥweṛma d yizerfan-ghur sen tamsakwit d lâquel u yessefk ad-tili tegmatt gar asen.

Translation

“All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood”. (Article 1 of the Universal Declaration of Human Rights)

Appendix A. An example of the neo-tafinagh alphabet as used in Morocco, a sample text in Tamazight, the transliteration of the text and, translation of the text into English (Adapted from Khalaf, 1996).

Amazigh is the singular of Imazighen meaning “free men” in Moroccan Berber (Maddy-Weitzman, 2006). Tamazight is spoken in areas of the Middle Atlas, High Atlas and rural area of the eastern High Atlas such as Taza, Khemisset, Azilal and Errachidia (Gordon, 2005). Tamazight is also taught in schools along with Arabic and French. Tamazight-speaking inhabitants are divided into three ethnolinguistic

groups; the Rif people who are also known as Riffi, or Riffians of the Rif Mountains, the people of the Middle Atlas, and the people of the High Atlas and the Sous valley (Rif, 2007) (Figure 2). Tarifit is spoken in rural Northern areas near to Al Hoceima (Gordon, 2005). While there are differences amongst the dialects, they are generally mutually comprehensible (Morocco, 2007).

The differentiations between Berber communities within the Rif region appear to be subtle. For example the Rif Berber would use the word 'amlal-ino' meaning 'my love' whereas the Amazigh would say 'a-agour-ino' meaning also 'my love'. The differentiation between origins appears to be based primarily on semantics and subtle differences in pronunciation and dialect, yet overall give each community a sense of individualism, value and pride, which appears to be becoming more important.

In Morocco during 2001 and 2002 demonstrations took place which called for the official acceptance of Berber identity and state-funded education in the Berber language. In more recent years the Maghrib, otherwise known as "the land of the setting sun" as interpreted in Arabic, has been seen to be encouraging a resurgence of Berber language and culture, which extends to teaching Berber language in schools and some Universities (Khalaf, 1996).

The population of interest to the present study is a particular tribal community which reside in the Rif and Atlas regions of Morocco in North Africa. For all intents and purposes it could be deemed 'Amazigh Berber' although the village in which I am especially interested clearly identifies itself as separate from the Amazigh even though most alike to them than any other Berber community.