The production and uses of cactus pears (*Opuntia ficus-indica*) in Mexico, Chile and Argentina

Report of a tour from 2 - 20 September 2012

by

HO de Waal, Herman Fouché, Maryna de Wit, Willie Combrinck and Coenie Erasmus

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Executive summary

The research programme at the University of the Free State (UFS) on the production and uses of spineless cactus pear (*Opuntia ficus-indica*) is augmented by information obtained from different sources. The information and knowledge are applied in implementing and developing the Cactus Pear Project at the Oppermansgronde in the Free State Province and elsewhere in the country.

Mexico, Chile and Argentina were visited from 2 to 20 September 2012 by a group of specialists to gain first-hand knowledge on the production and uses of cactus pear. All the objectives were met successfully.

- The knowledge gained on the entrepreneurial potential and possibilities of cactus pear cultivation, processing and uses can be widely applied.
- The cactus pear gene pool in Mexico, Chile and Argentina, as well as the USA can contribute to the gene pool in South Africa.
- A range of applications are available for cactus pear as human food, including traditional and commercial uses.
- Cactus pears and specifically natural colourants obtained from cochineal form the basis for several pharmaceutical applications.
- A range of applications are available for processing cactus pear cladodes as animal feed. Being its country of origin, cactus pears grow wild in Mexico and farmers are feeding it to livestock, mostly fresh chopped cladodes; cactus pear cladodes also supplement the water requirements of livestock in the dry regions.
- The cactus pear production systems on smallholdings are mostly traditional, but several new initiatives are being developed and implemented.
- Special attention is given to empower women in development projects based on cactus pear.
- The foundations were laid to exchange scientists, specialists and students to assist in various activities and topics, among others training, research and development, and education.
- The Bi-national Seminar (UAAAN, Saltillo, Mexico), Mini-Symposium (University of Chile, Santiago, Chile) and CACTUSNET FAO-ICARDA Meetings (Termas de Rio Hondo, Santiago del Estero, Argentina) provided excellent opportunity for scientific presentations and exchange of knowledge by three South African speakers with Mexican, Chilean, Argentinian, Peruvian, Brazilian and American colleagues and were greatly appreciated by all participants.

Contents

1 Background

The research programme at the University of the Free State (UFS) on the production and uses of spineless cactus pear (*Opuntia ficus-indica*) is augmented by information obtained from different sources. The information and knowledge are applied in implementing and developing the Cactus Pear Project[1] at the Oppermansgronde, west of Koffiefontein in the south-western Free State Province and also elsewhere in the Free State Province.



Since 2011 a formal agreement (Memoranda of Agreement) has been established between the partners in development, namely: Free State Department of Economic Development, Tourism and Environmental Affairs, University of the Free State and the Oppermansgronde Community Property Association



Dr. Herman Fouché demonstrated (1 August 2012) to the first group of 11 farmers at the Oppermansgronde the correct way to plant spineless cactus pear cladodes; a total of 21 ha has been enclosed to protect the new orchards; the second group of 15 farmers are currently being inducted into the Cactus Pear Project



Since 2004 animal diets (based on sun-dried and coarsely ground cactus pear cladodes) are being evaluated at the University of the Free State

[1] The Spineless Cactus Pear (*Opuntia ficus-indica*) Development Programme

Loaves of bread and carrot cake (wheat meal and oil has been substituted in part with cactus pear cladode meal and mucilage); mayonnaise (the eggs and oil are replaced by mucilage extracted from cactus pear cladodes)

Members of the team involved in the research and development at Oppermansgronde, namely Dr. Maryna de Wit, Dr. Herman Fouché and Prof. HO de Waal, attended the **VIIth International Congress on Cactus Pear and Cochineal** in Agadir, Morocco from 17–22 October 2010. Valuable experience was gained from the exposure to a broader group of renowned international scientists. Moreover, good personal contacts have been established with scientists working on cactus pears, specifically in Mexico, Chile and Argentina.

Early in 2012 it was realised more practical insight was needed regarding the research and development programmes and activities of selected groups of scientists in these countries and it could best be achieved during a tour by South African specialists. The information and experience gained in this way was urgently needed to inform the development of the research programmes at the UFS and, therefore, the Free State Province and especially the development at Oppermansgronde. It would also inform recommendations to local authorities on available technologies and applications regarding the production and uses of spineless cactus pears.

Planning for the scientific tour started on Friday 10 February 2012 by sending an email message to colleagues in the three countries, requesting assistance in planning an itinerary. The colleagues were reminded about contributions made by the South Africans at the Congress in Agadir, specifically our focus on processing of fruits and cladodes (human consumption), genetic resources, agronomy (small and large scale mechanization), and livestock feeds (all forms of processing and utilization).

The objectives of the tour to Mexico, Chile and Argentina were to investigate:

- and broaden knowledge on the entrepreneurial potential and possibilities of cactus pear cultivation in the Free State Province.
- the cactus pear gene pool and compare it with the local gene pool in South Africa.
- the range of applications for cactus pears as human food and basis for pharmaceutical development.
- the range of applications for processing the cladodes and fruits of cactus pears and its uses as animal feed.
- the way in which smallholding cactus pear production systems are operating.

The itinerary was planned to visit groups of scientists in Mexico, Chile and Argentina.

2 Mexico

The first leg of the tour focussed on the work conducted at three sites in Mexico, namely at Celaya, Guadalajara and Saltillo.

2.1 Dr. Candelario Mondragón Jacobo

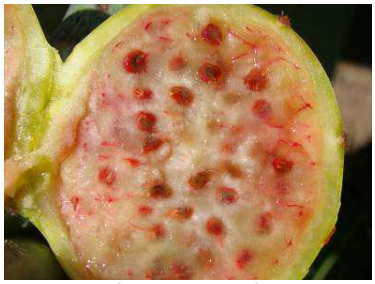
Instituto Nacional de Investigaciones Forestales y Agricolas y Pecuarias (inifap)
Programa de Nopal y Frutales
Campo Experimental Bajio CIR-Centro
Celaya, Guanajuato, Mexico

Dr. Candelario Mondragón Jacobo is a renowned specialist on the genetic resources of cactus pears. He arranged a courtesy visit and meeting with the Regional Director of INIFAP (Instituto Nacional de Investigaciones Forestales y Agricolas y Pecuarias), Dr. Eduardo Espitia Rangel. They showed great interest in negotiating a Memorandum of Understanding with the University of the Free State.


Dr. Candelario Mondragón Jacobo viewing with Mr. Willie Combrinck and Prof. HO de Waal some new hybrid cactus pear plants in a nursery propagated from seeds and then being evaluated for quality fruit production in an orchard exposed to local environmental conditions





A selection of cactus pear fruits with different skin and pulp colours and firmness of seeds currently being evaluated in an orchard by Dr. Candelario Mondragón Jacobo - plants have been propagated from seeds



There is an old saying "…**the proof of the pudding (cactus pear fruit) is in the eating**…"


A technician, Dr. Candelario Mondragón Jacobo and Dr. Maryna de Wit viewing a potentially good candidate hybrid cactus pear for quality fruit production; UFS caps were donated as token of appreciation to Dr. Candelario Mondragón Jacobo and his technical staff



A female shop attendant preparing young cactus pear cladodes (nopalitos) by scraping the spines off with a knife before being sold in the vegetable section of a supermarket in Celaya, Guanajuato, Mexico

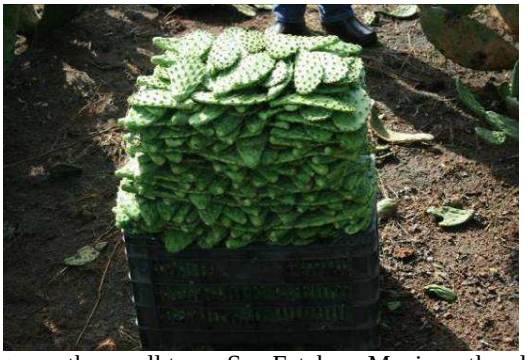
2.2 Dr. Liberato Portillo & Dra. Ana Lilia Vigueras

Universidad de Guadalajara
Departamento de Botánica y Zoologia-CUCBA
Zapopan, Jalisco, Mexico

Dr. Liberato Portillo and Dra. Ana Lilia Vigueras are renowned specialists on cochineal, the insect that feeds on cactus pears and which was introduced in South Africa to kill the spiny cactus pears growing wild in many areas. Time constraints did not allow intensive viewing of their work, but we obtained their recent compilation of research on cochineal. They also attended the Workshop in Termas de Rio Hondo, Santiago del Estero, Argentina. During the visit to Guadalajara they introduced us to smallholding farmers near the small town San Estaban, Mexico who are producing nopalitos for the fresh market.



A typical smallholding near the small town San Estaban, Mexico where young cladodes (nopalitos) are produced specifically for the fresh vegetable market – cactus pear orchards are fertilized with chicken manure; the South Africans are given background on nopalito production by a farmer (red shirt and blue jacket), agricultural advisor from *Zapopan Unido* Ing. Patricia Ortíz Silva (red cap; photo on the right), Dr. Liberato Portillo (white shirt; photo in the middle) and Dra. Ana Lilia Vigueras (blue top and jeans; photo in the middle)

Young cladodes (nopalitos) are harvested on a smallholding near the small town San Estaban, Mexico - the plastic crate contains about 30 kg fresh nopalitos


A young cladode (nopalito) ready for harvesting on a smallholding near the small town San Estaban, Mexico and a close up view of fresh nopalito with its small spines that must still be removed before being ready to be sold in shops as food



An impromptu demonstration by a skilled operator showing how the spines and edges of a nopalito should be trimmed, in this case even with a pocket knife


A farmer and two workers on his smallholding near the small town San Estaban, Mexico - having loaded crates with fresh young cladodes (nopalitos) (each crate contains about 30 kg fresh nopalitos); a new cactus pear field planted for production of nopalitos – new cladodes are planted to keep the plants small for nopalito (fresh hand-sized cladodes) production

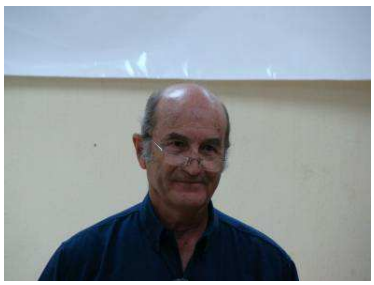
2.3 Dr. Jesus Fuentes Rodriquez

Universidad Autónoma Agraria Antonio Narro (UAAAN)
Saltillo, Coahuila, Mexico

In preparation for this visit to Saltillo, Dr. Jesús M. Fuentes Rodriquez organized the First Binational Mexico-South Africa Seminar at the Universidad Autónoma Agraria Antonio Narro (UAAAN). The programme included three South African speakers, several Mexican colleagues and four graduate students.

Preparing for the official opening of the first *Seminario Binacional México-Sud África* by the Rector of UAAAN, Dr. Eladio H. Cornejo Oviedo (third from the left in conversation with Dr. Herman Fouché) and other dignitaries in Saltillo, Coahuila, Mexico; part of the audience (students and lecturers) while the seminar was in progress


South Africans presenting (with the aid of an able interpreter, Dr. Ricardo Silva) - Dr. Herman Fouché (Available Genetic Resources and its potential in South Africa) and Dr. Maryna de Wit (Cactus pear food quality: carbohydrates, seed oil and antioxidants) [Prof. HO de Waal not shown (Recent advances in the utilization of sun-dried and coarsely ground *Opuntia ficus-indica* cladodes as animal feed in South Africa)]; Dr. Jesús M. Fuentes Rodriquez [Utilización de Nopal (*Opuntia* spp.) Forrajero en el Norte de México]


A selection of presenters at the seminar: Dr. Juan José López González (an animal scientist), Arq. Francisco Dávila Ramos (an architect) and Dra. Maria Elena Murillo Soto (a sociologist) – the latter two are engaged in the family enterprise where a housewife and her husband are producing food items from cactus pears in a small village



More presenters at the seminar: Dr. Ana Verónica Charles Rodriguez (studying the effects of enzyme supplementation to cactus pear diets on *in vitro* rumen fermentation) and Dra. María Margarita Murillo Soto (a food scientist); Mr. Willie Combrinck gaining more information from Arq. Francisco Dávila Ramos

South African presenters posing with Dr. Jesús M. Fuentes Rodriquez and four graduate students proudly wearing UFS caps in recognition for presenting short research papers at the seminar (in no particular order: Cynthia Herrera Palacios, Andrés Junior Rodriguez Sánchez, José Gabriel Sánchez Sánchez, Elia de la Rosa Hidalgo)

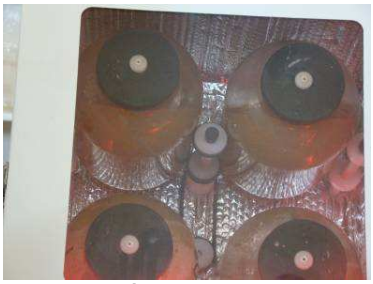


The Rector of the Universidad Autónoma Agraria Antonio Narro (UAAAN) Dr. Eladio H. Cornejo Oviedo signing and sealing a **Memorandum of Understanding** with the University of the Free State (UFS) in the presence of Dr. Maryna de Wit, Prof. HO de Waal, Dr. Jesús M. Fuentes Rodriquez and Dr. Herman Fouché





Graduate students at the UAAAN conducting feed intake trials with sheep and goats being supplemented with cactus pear cladodes, agave flowers and enzymes to promote rumen function




In vitro experiments conducted Dr. Ana Verónica Charles Rodriguez and colleagues in the animal nutrition laboratory at the UAAAN




Cactus pears are prone to severe frost bite at high altitudes such as at Saltillo (-14°C). Dr. Fernando Borrego Escalante (with white shirt and crutch) is evaluating cactus pear successions from different regions in northern Mexico that show some degree of tolerance to extreme cold conditions

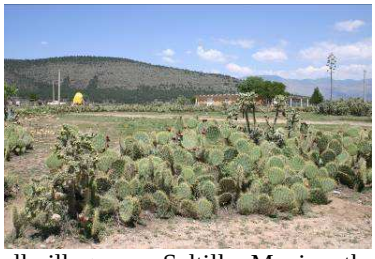
A demonstration of the traditional way still used by many farmers in northern Mexico to singe the long spines of cactus pear cladodes on the flames of a wood fire before it is cut with a machete and fed to cattle – the high water content of cladodes also serve to supplement the daily water requirement of cattle in the dry zones of Mexico

A family in the small village near Saltillo, Mexico who are producing various food types from cactus pears, both from nopalitos as well as cactus pear fruits in their modified kitchen

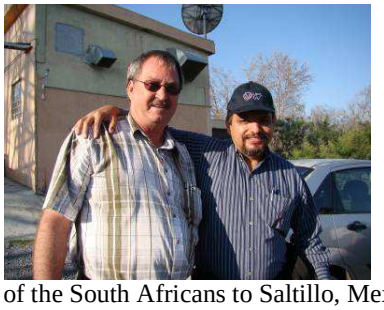
Arq. Francisco Dávila Ramos wearing his new UFS cap explaining the detail of the processing of different cactus pear food products to Mr. Willie Combrinck and Dr. Herman Fouché, while Dr. Maryna de Wit is making notes and taking photographs of the different processed food items





The small cactus pear orchard in the backyard of the family enterprise in the small village near Saltillo, Mexico; the big spines on wild cactus pear varieties outside the backyard


Special publicity was given to the visit of the South Africans to Saltillo, Mexico and specifically the UAAAN: the South Africans were interviewed in a live broadcast by the local private radio station in Saltillo, Mexico (again Dr. Jesús M. Fuentes Rodriquez was the able translator); new friendships were forged around a UFS cap with Lic. Sergio Salvador Garciá Rivera (the advisor of the Rector: UAAAN); and an interview with two South Africans going live on the noon show of the TV station in Saltillo, Coahuila, Mexico

3 Chile

Following the visit to Mexico, the second leg of the tour was conducted in Chile and focussed on work conducted by scientists at the University of Chile in Santiago and La Serena.

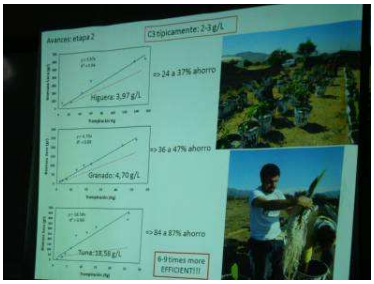
3.1 Dra. Carmen Sáenz & Dr. Nicolás Franck

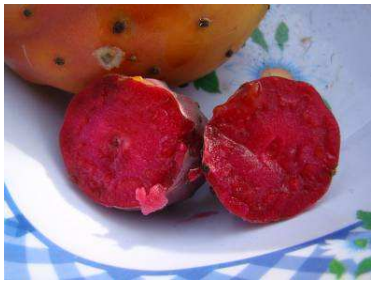
Universidad de Chile
Facultad de Siencias Agronómicas
Campus sur Antumapu
Santiago, Chile

The visit to Chile started in Santiago with a mini-symposium "Current research on *Opuntia ficus-indica* at the University of the Free State (UFS), South Africa and the University of Chile (UCH)" held at the Campus sur Antumapu of the University of Chile.

The speakers at the mini-symposium, posing in the cactus pear orchard on south Antumapu Campus of the University of Chile – a wide range of accessions are maintained as genetic resource (germplasm collection) [Dra. Carmen Sáenz – center, wearing brown trousers & Dr. Nicolás Franck – with his arms folded]

A mini-symposium was held at the Campus sur Antumapu of the University of Chile. It was well attended by lecturers and student between their own business of attending classes and presenting lectures







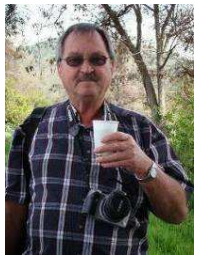
The mini-symposium held at the Campus sur Antumapu of the University of Chile was concluded with a visit to field trials on campus; Dra. Carmen Sáenz and Dr. Maryna de Wit discussing detail of cactus pear produce






One of the larger cactus pear farms near the small town Til-Til (meaning very dry), in the central valley of Chile north of Santiago was visited and treated to a late breakfast consisting of various produce made from cactus pears (cladodes and fruits); the farmer (with arms folded in photo bottom left) drives on a daily basis to and from Santiago; Dr. Nicolás Franck explaining some detail of the activities on the farm





…and a healthy toast to our hosts in Chile with a glass of fresh green (nopal - cactus pear cladode) juice…

3.2 **Dr. Nicolás Franck**
Universidad de Chile
Facultad de Siencias Agronómicas
Director: CEZA –Centro de Estudios de Zona Áridas
La Serena, Coquimbo Region, Chile

The second phase of the visit to Chile was conducted at La Serena and Coquimbo, which is about 450 km north of Santiago. Among others, research is conducted at this facility on plants suitable for the dry regions, such as figs






Activities at the Las Cardas Experimental Farm of the University of Chile are focusing on plants suited for the dry regions of northern Chile; the nursery is the process of being relocated to a more secure site on the farm because of cable theft (?)




Posing with new friends Sra. Denisse Amorano, Dr. Victor Muñoz and Sra. Valentina Vesely; the group in front of the office and laboratory at the Las Cardas Experimental Farm of the University of Chile



A jojoba (*Simmondsia chinensis*) orchard - the seeds are used for their oil content – the oil makes up approximately 50% of the jojoba seeds by weight; Delicious cheese is produced by Ing. Claudia Torres from goat milk at Las Cardas Experimental Farm; some Boer goats also form part of the goat dairy flock



A big citrus farm has been bought by a new owner – he is not particularly convinced about the financial merits of the large cactus pear orchards – however, it would seem that the production records kept by the manager may help to convince the owner differently; an interesting but practical local patent to close off the end of an irrigation water pipe



Note how the cladodes have been planted simply by laying it down flat on the soil – the plants have very shallow root systems and tend to be blown over by strong wind

4 Argentina

4.1 Sra. Judith Ochoa

Universidad Nacional de Santiago del Estero
Termas de Rio Hondo
Santiago del Estero, Argentina

Due to a time constraint, only two days could be devoted to attend the meeting in Termas de Rio Hondo, Santiago del Estero in north-western Argentina.

A large contingent of scientists and specialists from Mexico, Chile, USA, Argentina, Brazil and South Africa attended the "1ST SOUTHAMERICAN MEETING CACTUSNET FAO-ICARDA and SECOND MEETING on INTEGRAL USE OF CACTUS PEAR AND OTHER CACTI".






South Africans (Dr. Herman Fouché, Prof. HO de Waal, Dr. Maryna de Wit & Mr. Coenie Erasmus) listening and colleagues (Dra. Ana Lilia Vigueras & Ing. José Antonio Bustamante; Dr. Herman Fouché & Dra. Gabriela Romano – Horticulturist-Curator of the National Arid Land Plant Resource Unit, USDA, California; Dra. Gabriela Arroyo Figueroa & Dra. Ana Lilia Vigueras; Ing. Enrique Arias – founder and past president of the International Cactus Network CACTUSNET) participating in a news conference before the meeting; the group posing after the news conference



Ing. Judith Ochoa, the driving force and organiser of the meeting in Termas de Rio Hondo, Santiago del Estero, Argentina; the dignitaries at the opening session; Dr. Maryna de Wit and Mr. Willie Combrinck in front of a poster publicising the meetings

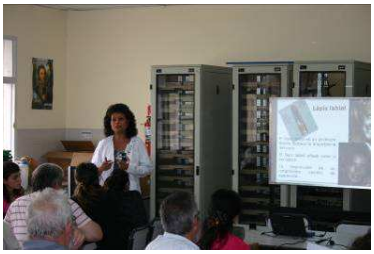
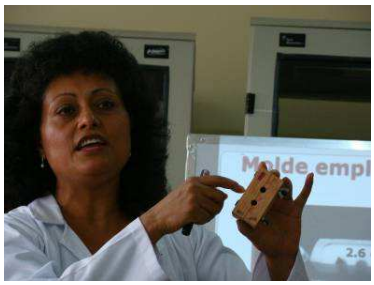
Ing. Enrique Arias from Mexico, a leading specialist on cactus pears delivered an invited paper on the global distribution and importance of cactus pear and emphasised the role of cactus in the Mexican history – the **Mexican Coat of Arms** depicts a Mexican golden eagle atop a cactus (or nopal) pedestal devouring a snake

The South African speakers in jovial mood before the meeting started; Prof. HO de Waal presenting, with the able assistance of Dr. Jesús M. Fuentes Rodriquez who translated in Spanish; during the tea break participants were given opportunity to taste and appreciate a range of cactus pear produce

Colleagues from Argentina, Mexico, Peru and South Africa became good friends in a very short period as shown by the jovial mood during a typical Argentine lunch



The meeting in Termas de Rio Hondo, Argentina was conducted in Spanish and the South African visitors had the benefit of Ing. José Antonio Bustamante as translator; Ing. Paulo Suassuna and Dr. Dr. José Carlos Dubeaux Jr. (both are not shown) elaborated on high density cactus orchards for livestock feed respectively in Sergipe and Pernambuco, Brazil; products were tasted and old acquaintances (Dra. Maria Elena Murillo Soto from Saltillo, Mexico and Dr. Maryna de Wit and a student) were renewed and new friends made



An afternoon was devoted to a series of demonstrations in the laboratory of a local technical school: Dra. Gabriela Arroyo Figueroa showed the audience how to make lipstick from natural colourant (carmine acid extracted from cochineal) and then Biol. Dora Corvalán entertained the audience on practical ways to include nopalitos and cactus pear fruit in different dishes



Ing. Enrique Lobos and Sra. Adriana Habra took the South Africans back by car from Termas de Rio Hondo to the airport at Santiago del Estero, Argentina for the flight back to Buenos Aires. Along the road they stopped to view a typical smallholding in north-western Argentina with a small cactus pear orchard of about 1 ha next to the homestead

5 Conclusions

The broad goal and objectives set for the tour to Mexico, Chile and Argentina were met successfully. Possible outcomes are listed below per country.

5.1 Mexico

5.1.1 **Dr. Candelario Mondragón Jacobo** extended an invitation for a student involved in the cactus pear project to be trained in cultivar selection techniques.

5.1.2 Due consideration was given to exchange and breeding/selection of suitable cultivars.

5.1.3 The techniques employed can be used to select among local cultivars in South Africa.

5.1.4 About 10 *Opuntia* species are available in Mexico compared to only two species in South Africa. Most of the Mexican cactus species are spiny but some may have potential for local application.

5.1.5 There is an interest in the germplasm collection of the Burbank spineless varieties in South Africa.

5.1.6 Research conducted on the selection of pomegranate and figs (dry areas), which is also relevant for South African conditions, is worthy of further investigation.

5.1.7 **Dr. Liberato Portillo** is Chairman of the International Cactus Network and his contacts with the international research community are valuable. He is an expert in cochineal breeding for carmine acid dye production.

5.1.8 **Dra. Ana Lilia Vigueras** is also an expert in cochineal production and has experience in establishing and promoting cactus pear production and processing of by-products in Ethiopia. Her input in the establishment of small processing units in South Africa will be valuable.

5.1.9 If the nopalito market can be promoted in South Africa, valuable information can be sourced in the production and marketing of the product.

5.1.10 This group of people are experts in implementing smallholding entrepreneurial initiatives and the contacts should be fostered and utilised.

5.1.11 There is great potential to exchange students on various topics.

5.1.12 **Dr. Jesús Fuentes Rodriquez** and members of his group are actively engaged in improving the utilization of cactus pear cladodes by livestock.

5.1.13 At Saltillo, Dr. Jesús Fuentes Rodriquez organized the First Bi-national Mexico-South Africa Seminar at the Universidad Autónoma Agraria Antonio Narro (UAAN). The programme included three South African speakers, several Mexican colleagues and four graduate students. This interaction was greatly appreciated by all participants. Similar exchanges are necessary.

5.1.14 Dr. Jesús Fuentes Rodriquez has broached the prospect of doing a post doctorate at the University of the Free State in the near future.

5.1.15 Published results (Lopéz-Garcia *et al*., 2001): Consumption of fresh *Opuntia* cladodes for cattle was estimated at 15 to 40 kg per cow/day in Mexico. However, under drier conditions, if plant yield is abundant, the consumption was as high as 90 kg per cow/day. In the case of sheep and goats, consumption ranges from 3 to 9 kg per day, which may be less if other sources of food are also available.

5.1.16 It is common for Mexican farmers to singe the long spines of cladodes with gas burners or traditional wood fires before cladodes are being utilised by livestock; the water content

of cladodes contributes markedly to the daily water requirements of livestock in the dry areas.

5.1.17 **Dra. Maria Elena Murillo Soto** (the wife of Dr. Jesús Fuentes Rodriquez) is an expert in the art of empowering women. This knowledge is valuable, especially in training the women of the Project at the Oppermansgronde. She is also interested in joining her husband to do a post doctorate at the UFS**.**

5.1.18 **The Memorandum of Agreement between the two institutions (UFS and UAAAN) was signed and must be followed up with practical engagements and projects.**

5.1.19 This group at the UAAAN, including **Dr. Juan José López González**, is actively engaged in conducting research on cactus pear cladodes as livestock feed. The knowledge and skills must be integrated with local expertise at the UFS.

5.1.20 **Arq. Francisco Dávila Ramos** has experience in the establishment of cactus pear orchards and the training of farmers in processing of by-products and is working with Dra. Maria Elena Murillo Soto. He has developed training material in the form of DVD's and guidelines.

5.1.21 There is good prospect for exchanging genetic resources.

5.1.22 The UAAAN gave prominent publicity to the visit by the South Africans. During the short visit to Saltillo, two radio interviews and a TV interview were arranged to inform the broad university community and public in the province on our visit regarding cactus pears and the cooperation between the UFS and the UAAAN.

5.1.23 Some of participants in the Cactus Pear Project at the Oppermansgronde may benefit by gaining experience during a visit to selected sites in Mexico.

5.1.24 Some of the specialists may be invited to visit South Africa and to assist in doing some of the training in the Cactus Pear Project.

5.2 Chile

5.2.1 **Dra. Carmen Sáenz** is an expert regarding food applications of cactus pear and is very interested in the research done by the UFS.

5.2.2 She is keen to be involved in the development of new products and applications of mucilage and colourants in food products.

5.2.3 The mini-symposium held at the Campus sur Antumapu, the University of Chile created a good platform to present scientific content and interact with colleagues engaged in processing cactus pear produce.

5.2.4 There is good prospect for exchanging genetic resources.

5.2.5 **Dr. Nicolás Franck** has shown keen interest to become involved in the local Cactus Pear Project. The Centre for the Arid Zone Studies (CEZA) is engaged in establishing other commodities such as pomegranates and figs.

5.2.6 There is good prospect of exchanging scientists and students between institutions.

5.3 Argentina

5.3.1 Ing. Judith Ochoa was the driving force and organiser of the meeting in Termas de Rio Hondo, Santiago del Estero, Argentina; prominent publicity was given in a press conference to the meeting on cactus pears and the visit by the South Africans.

5.3.2 The South Africans presented scientific content and had good interactions with Mexican, Argentinian, Peruvian, Brazilian, and American colleagues. Similar events can be arranged in South Africa.

5.3.3 It was an honour to renew and foster old acquaintances with colleagues, especially with Ing. Enrique Arias the founder and past president of the International CactusNet. He has now retired to his hometown in Mexico. It may be very useful to capitalise on his vast experience by inviting him to South Africa.

5.3.4 **Dra. Gabriela Romano** from the USDA, California is the Horticulturist-Curator of the National Arid Land Plant Research Unit of the USDA, California - it is also the origin of the Burbank spineless cactus pear types. She is very interested to share in our cactus pear gene pool.

5.3.5 We established very good contact with the delegation from Peru (**Ing. José Antonio Bustamante** and **Ing. Miguel Christian Bengtsson**). They are experts in establishing cochineal industries in different countries, such as Ethiopia. As a result they import 2000 tons of cochineal from Ethiopia.

5.3.6 The delegation from Brazil **Ing. Paulo Suassuna** and **Dr. José Carlos Dubeaux Jr**. have vast experience in the production and application of cactus pear as livestock feed in the arid northeast of Brazil. Cactus pear is making a major impact as livestock feed in north-eastern Brazil. For example, the carrying capacity of natural pasture in the dry northeast of Brazil is 12 ha/LSU. By incorporating cactus pears as livestock feed in Pernambuco, Brazil productivity is increased to 48 LSU/ha; that is a 57.6 fold increase in productivity (Dr. José Carlos Dubeaux Jr.). Similarly, cactus pears are planted at very high densities as livestock feed in the dry region of Sergipe, Brazil (Ing. Paulo Suassuna).