A Review of Applied *Opuntia* Forage Production Technologies and Costs for Northeastern Brazil♦

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1. INTRODUCTION

The increasing desertification phenomenon in the Brazilian northeastern area is one of the main reasons that lead farmers in this semiarid region to lose their crops.

In a partnership survey with EMBRAPA during the 1990s, it was established that the Brazilian northeastern region has an approximate area of 1,600,000 km² and 75% of it (1,200,000 km²) is classified as semiarid. Also, it was acknowledged that in this dry region, 90% of the rural properties are less than 100 ha, and within it, 75% are less than 20 ha. Therefore, the greatest amounts of existing properties in this area are small agricultural modules or properties.

The average precipitation in the Brazilian semiarid region ranges from 350 to 800 mm. In this region, there are only two well-defined weather conditions or seasons: rainy (3 to 4 months) and dry (8 to 9 months). It is rather common and cyclical that, from every 7 to 10 years the rainy season just disappears, turning that particular year into a completely dry one: Drought.

PICTURE Nº. 1

The challenge is then: How to transform a small piece of land, located in the semiarid region, to produce the resources to guarantee the subsistence of its owner?

The prickly pear, being a highly resistant plant regarding drought, particularly due to its physiology and complete anatomical and morphological structure, offers a real alternative to use in the semiarid region conditions, therefore, demanding specific agronomic techniques to support its maintenance, production, and advantages.

The Prickly Pear Intensive Cultivation Technology (PPICT) has been developed since the early 1990s to minimize this problem. Combinations between appropriate land choice, cladodes selection, soil preparation, fertilization, plant density, culture handling, and systematic cladode cutting, has given the prickly pear an annual productivity superior to 400 tons per hectare.

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With this approach, even in a small piece of land, it is possible to guarantee strategic resources of energetic forage so as to cope within the drought cycle, maintaining the cattle in perfect nutritional conditions, which results in landowners achieving a better quality of life.

2. PRODUCTION SYSTEM

Choosing The Planting Area

The prickly pear has a preference to grow on sandy soil without the risk of soaking and with slight topography. Shallow soil with accentuated rockiness and high levels of acidity and salinity must be avoided. It is necessary to carefully perform a soil analysis. Preference must be given to soil previously used for annual cultivation to avoid further deforestation.

PICTURE Nº. 2

If the soil is uneven and already eroded, there will be no problem whatsoever, for prickly pear becomes the best option as a controlling device for soil erosion when correctly planted.

The distance between the orchards and the processing area must also be considered because it may raise production costs.

Cladode Selection

PICTURE Nº. 3

First, the most adequate variety for the region must be chosen. The most verdant matrix plants must be selected. Afterwards, healthy and vigorous cladodes located in the middle of the plant, neither green nor too ripe (approximate age: 8 to 12 months), should be chosen.

Cladode Cutting (Cutting)

PICTURE Nº 4

Cladodes must be cut off at its joint with a clean sharp knife to avoid possible contamination.

Cladode Dehydration (Resting)

PICTURE Nº. 5

After cutting, cladodes are allowed to heal for 12 days during the hottest part of the year and for 15 days when the weather is milder. This cladode wound healing favours sprouting buds and rooting processes and decreases replanting (replacement of dead plants).

Fencing

PICTURE Nº. 6

Cultivation areas must be fenced to avoid animal intrusion. In the specific case of prickly pear, fencing is necessary because during drought periods vegetation dries out and animals start to search for prickly pear more intensely.

Setting Up The Soil

Follow directions given below to set up the soil.

Soil Setup Using Human Ploughing

PICTURE Nº. 7 AND PICTURE Nº. 8

Furrows must conform to level curves (retaining water *in situ*). Using a special hoe or pick, dig the soil with an average depth of 0.30 m and row spacing of 1.80 m (*Opuntia sp*.) or 1.40 m (*Nopalea sp*.) in order to facilitate culture handling during its cycle.

Soil Setup Using Animal Traction

Use a mouldboard plough system with animal traction and repeat the process passing twice through the area to increase the soil revolving depth up to 0.30 m.

PICTURE Nº. 9

Trace furrows in accordance to level curves (retaining water *in situ*), with an average depth of 0.30 m and using a one-line animal traction furrow opener and with the same row spacing mentioned above.

Soil Setup By Tractor

It is highly important to root out the soil in order to provide safe and adequate tractor operation.

Grind the soil with a subsoiler plough with 3 to 5 pole cultivators, depending on the tractor's power, from 0.60 m to 0.70 m depth.

PICTURE Nº. 10 AND PICTURE Nº. 11

If after subsolation the soil still contains large solid chunks of earth because of the presence of argil, the grinding process with a disc harrow must be carried out.

PICTURE Nº. 12 AND PICTURE Nº. 13

Use a double-line furrow opener device to create distances between furrows already mentioned.

PICTURE Nº. 14

Furrows should be in accordance with level curves with an average depth of 0.30 m.

PICTURE Nº. 15 AND PICTURE Nº. 16

Fertilizing Plan

> *"The Phosphorus fertilization rates and timing were based on previous unpublished trials by the author."*
>
> *"There is no Prickly Pear rational production without due soil correction and fertilization." (P. Felker, pers. comm. 1994 and 2007).*

Based on that information and the fact that the prickly pear can significantly improve as a forage when correctly fertilized with nitrogen and phosphorus (Gonzalez, C.L. and Everitt, J.H., 1990) and (Felker, 2001), after interpretation of soil analysis, in order to obtain better results in productivity, proceed to fertilization in two stages looking forward to stabilize N and P_2O_5 levels to 270 and 216 kg per hectare, respectively, as follows:

- Fundamental Fertilization, realized before planting.
- Covering Fertilization, realized after planting.

Fertilization plans only for the first and second year of planting will be detailed because from this point on, the fertilization process will be identical for years to come.

Fundamental Fertilization (First Year)

The prickly pear is very demanding for organic matter, phosphorus and potassium. Therefore, before the planting process, the amounts must be put in the furrows as described below:

Simple superphosphate as P_2O_5 source

PICTURE Nº. 17

216 g per meter in each furrow

Dung as organic matter source (goat, ovine, or bovine)

PICTURE Nº. 18

2.7 kg per meter in each furrow on top of simple superphosphate. This guarantees an approximate amount of 15 to 19 tons of dung per hectare to *Opuntia* sp. or *Nopalea* sp. cultivation, respectively.

OBS: If the soil is heavy (high levels of clay), fertilization using dung in the furrow must be avoided for it will lead to loss by rotting of the plant base. To avoid the rotting, spread the dung between the rows.

NOTE: The soil formation on the Brazilian semiarid region is rich in potassium. To use this element in PPICT, interpreting soil analysis is recommended.

Covering Fertilization (First Year)

During winter, with the prickly pear already planted and sprouted, proceed to covering fertilization. To obtain an increase in number, size and protein percentage on cladodes, mostly

in the case of *Opuntia* sp. See Table 1 - Data collected at Malhada farm –Logradouro – Paraíba - Brazil) must use urea as nitrogen resource. Fertilization must always be performed with a wet soil and divided in three parts to avoid loss through volatility and lixiviation in quantities described as follows:

PICTURE Nº. 19

1st Application: 36 g of urea per meter of furrow, alongside the plants at the beginning of winter.

2nd Application: 36 g of urea per meter of furrow, alongside the plants at the middle of winter.

3rd Application: 36 g of urea per meter of furrow, alongside the plants at the end of winter.

OBS: If the soil contains a higher percentage of clay, nitrogen fertilization may be decreased to 3 applications of 30 g per meter of furrow.

NOTE: Through field observations, protein level within cladodes may vary according to rainfall. Nitrogen absorption levels are compromised when rainfall decreases during the winter, and as a consequence, protein levels also decrease.

Covering Fertilization (Second Year And Forth)

Every year, after harvesting prickly pear cactus, soil samples must be collected and subjected to new analysis and interpretation. The main idea is to maintain N and P_2O_5 levels stabilized between 270 and 216 kg per hectare, respectively. For that matter, during rainy periods, covering fertilization must be performed. If, after soil analysis interpretation, it is noticed that all nourishments offered were consumed in the previous cultivation cycle, 4 fertilizations within 20 days must be realized, the first being at the beginning of the winter, using MAP (monoammonic phosphate, 400 kg per hectare) as a P_2O_5 resource to a proportionate degree of 72 g per meter, alongside the plants (*Opuntia* sp.) or 56 g (*Nopalea* sp.). The second and third fertilizations must be carried out using urea as N resource at a proportionate degree of 45 g per meter (*Opuntia* sp.) or 35 g (*Nopalea* sp.). Finally, by the end of the winter, the fourth fertilization must be carried out using dung (30 tons per hectare) at a proportionate degree of 5.4 kg per meter (*Opuntia* sp.) or 4.2 kg (*Nopalea* sp.), distributed between rows. If the plants did not consume all the nourishments offered in the previous cultivation cycle, only the complement to maintain N and P_2O_5 levels balanced to a proportionate degree of 270 and 216 kg per hectare, respectively, must be provided.

PICTURE Nº. 20 AND PICTURE Nº. 21

Use caution with soil acidity regarding the urea fertilizing process. If soil pH starts decreasing, it is suggested to perform soil correction using dolomitic calcite and replacing the nitrogen resource with potassium nitrate KNO_3 because it does not make the soil more acid, while both ammonium nitrate and urea do. (P. Felker, pers. comm. 2007). Due to the very shallow *Opuntia* root system, fertilizers rapidly leach below the root zone; therefore, it is best to use many applications of low rate than a single large application.

NOTE: All fertilizing levels proposed on PPICT have been intensively tested and corrected, through experiments, since the early 1990s in farms located in the Brazilian semiarid region and based on scientific research results from different countries to achieve the best productivity results.

Planting

With the soil already set up, fundamental fertilization process finished, and prickly pear rested for 12 to 15 days, proceed to the planting process. This must be performed preferably a month before the rainy period.

Believing that prickly pear burns through the incidence of sun beams when planted facing an east-west direction, farmers from the Brazilian semiarid region normally plant them facing the north-south direction.

Looking forward to increase photosynthesis and, as a consequence, it's sprouting, rooting process, and biomass growth, between 30º latitude north or south the cladodes must be planted facing east-west, respectively, (Nobel, 1994).

From field observations made between 1994 and 2007 it was noticed that the majority of cladodes that were planted on a north-south direction, already sprouted facing an east-west alignment, present a lower production rate. For that reason and in association with scientific evidence, it was decided, with this new technological production model, to invert the cladode orientation leaving the prickly pear "faces" in an east-west alignment.

In The Intensive Cultivation Technology, the prickly pear can be planted in two ways, always considering its alignment in relation to the sun axis.

Different spacing can be applied to cladodes. The planting density to be used will depend on weather and soil conditions (Nobel, 1994), as well as the presence of wild Cochineal - *Dactylopius opuntiae* (Zimmermann, H. G., pers. comm.).

Planting With Bilateral Cladode Alignment (Domino)

PICTURE Nº. 22

In normal weather and soil conditions, use 11 cladodes per linear meter of furrow, organized in an offset manner (one after the other) at a distance of 0.09 m and 50% of its base embedded in the furrow, with the help of a little hoe using adhesive tape on its handle to control cladode spacing.

PICTURE Nº. 23

In the case of *Opuntia* sp. with 1.80 m spaces between rows and with cladodes 0.09 m in an offset manner, there will be a density of 60,000 cladodes per hectare.

In the case of *Nopalea* sp. with 1.40 m spaces between rows and with cladodes 0.09 m in an offset manner, there will be a density of 78,000 cladodes per hectare.

Using this planting technique, furrows must be aligned according to level curves (retaining water *in situ*). In the case of a flat terrain, furrows must be aligned east-west.

PICTURE Nº. 24

NOTE: In the case of heavy terrain (high level of clay) or in a rainy region, planting must be done on top of furrow to avoid cladodes rotting on their bases.

Cladode Planting With Simple Superposition (Deck Of Cards)

PICTURE Nº. 25

In this planting technique, use 11 cladodes per linear meter of furrow, juxtaposed (one beside another) with 50% of its base embedded in the furrow, with the help of a hoe on the furrow's west wall to avoid cladode burning.

PICTURE Nº. 26

In the case of *Opuntia* sp. with 1.80 m spaces between rows and with cladodes juxtaposed, approximately 60,000 cladodes per hectare will be used.

In the case of *Nopalea* sp. with 1.40 m spaces between rows and with cladodes juxtaposed, approximately 78,000 cladodes per hectare will be used.

Using this planting technique, furrows must be aligned according to level curves. In the case of flat terrain, furrows must be aligned north-south.

PICTURE Nº. 27

NOTE: In the case of heavy terrain (high level of clay) or in a rainy region, planting must be done on top of the furrow to avoid cladodes rotting on their bases.

Cladode Planting With Double Superposition (Double Deck Of Cards)

In this case, consider two different cladode dispositions into the furrow.

- Simple furrow
- Double furrow

PICTURE Nº. 28

With simple furrowing, 22 cladodes for each linear meter of furrow must be used, cladodes juxtaposed, on both sides of the furrow, embedded with 50% of its base in the furrow using a hoe.

In the case of *Opuntia* sp. with 1.80 m spaces between rows and with cladodes juxtaposed on both faces of the furrow, approximately 120,000 cladodes per hectare must be used.

In the case of *Nopalea* sp. with 1.40 m spaces between row and with cladodes juxtaposed on the two faces of the furrow, approximately 156,000 cladodes per hectare must be used.

PICTURE Nº. 29

With a double furrow, during soil set up, furrows are double and spaced accordingly to attend plant needs.

If *Opuntia* sp., use a double furrow for each 1.80 m and, if *Nopalea* sp., use a double furrow at each 1.40 m. Using 22 cladodes per linear meter of furrow, cladodes juxtaposed (one beside another), but on the internal parts of the furrows embedded within 50% of its base in the furrow using a hoe.

In the case of *Opuntia* with 1.80 m spaces between rows and with cladodes juxtaposed on the two internal faces of the furrow, approximately 120,000 cladodes per hectare must be used.

In the case of *Nopalea* with 1.40 m spaces between rows and with cladodes juxtaposed on the two internal faces of the furrow, approximately 156,000 cladodes per hectare must be used.

Using this planting technique, furrows must always be aligned according to level curves. In the case of flat terrain, furrows must be aligned north-south.

NOTE: In the case of heavy terrain (high levels of clay) or in a rainy region, plantation must be done on top of the furrow to avoid cladodes rotting on their bases.

Culture Handling

Weeding

When prickly pear is planted, from the first year, and due to incoming rainfall and mostly because of the use of dung and fertilizer there is a strong tendency of weed to invade.

The prickly pear, being a desert plant and for that reason highly demanding on nourishments and solar energy, it is highly important not to “relax” with weed control. At least three hoe cleanings are required every year to prevent weeds from competing for sunlight, nourishment, and water with prickly pear, lowering its production level.

PICTURE Nº. 30 AND PICTURE Nº. 31

Cleanings not only prevent weed growth but favours air entry into the soil, improving prickly pear development. However, at this moment, one must be extremely careful not to hit the plants radical system because prickly pear growth is negatively affected when that happens.

As an experiment, preemergent herbicide applications (Ametryne, Diuron and Tebuthiuron) as well as postemergent herbicides (Gliphosate, Simazine and Atrazine) had a significant result on controlling weed invasion and production costs without harming the prickly pear and the environment.

Pests And Diseases – Prevention And Control

In Brazil there are no registered chemical defense agents for prickly pear culture, thus it is difficult to develop a control for pests or diseases in prickly pear without intervention from regulatory agencies. The main pests that can cause economic damage to prickly pear culture in Brazil are the cochineal (*Diaspis* sp. and *Dactylopius opuntiae*), caterpillar, grasshoppers, and ants.

The main disease that can cause economic damage to prickly pear culture is rotting caused by fungus.

Applying insecticides, 1.0 litre per hectare of one of the following products (Confidor, Provado, Carbaril, Endosulfan, or Carbofuran) and with fungicides 1.0 kg per hectare of Metiltiofan or Cercobim, produced results significant to the control of caterpillar, grasshoppers, ants, and fungus in our farm.

PICTURE Nº. 32

This new technological model helps the application handling for prickly pear which is cultivated within larger row spaces (1.80 m for *Opuntia* sp. and 1.40 m for *Nopalea* sp.) and that allows applicants to freely access plantation rows.

Harvest

It is very important that prickly pear be cut annually with the objective of keeping it always healthy, for it prevents pests and disease problems. This also gives prickly pear higher resistance to drought periods because it decreases the transpiration active surface.

Only at the first time, the prickly pear must be cut after 1 year and 1 winter, (approximately 18 months) because prickly pear must be planted before the first year's winter and cut after the winter of the following year. From now on, right after the rainy periods, prickly pear must be cut furrow after furrow (during drought) and on a daily basis offered to livestock, maintaining its level of quality as forage.

PICTURE Nº. 33

From the first to the third or fourth harvest, the cutting must be performed between the matrix cladode and primary cladodes, on its joints, with a clean sharp knife to avoid contamination. For that reason the producer must be attentive to the sprouting conditions of the matrix cladode.

PICTURE Nº. 34

If the producer notices that the matrix cladode will not sprout again after that cutting (the cladodes become blind) then, cutting must be performed leaving approximately 0,05 m off the primary cladode base near the matrix cladode. This procedure will provide super sprouting on each matrix cladode that must be covered with earth right after sprouts are grown to increase rooting process.

From then on, these sprouts must be treated as matrix cladodes and the harvesting process will be repeated until the twentieth year.

PICTURE Nº. 35

Using these procedures the producer is keeping a reserve and offering sufficient energetic forage of excellent quality so as to maintain livestock in perfect nutritional conditions, even though the drought cycles are common to the Brazilian semiarid region.

Performance

The prickly pear plantation productivity directly relates to the production system. With prickly pear intensive cultivation technology, where the producer is demanding about cleaning, fertilization, and culture handling, 400 tons annual productivity per hectare (40 tons dry matter) can easily be achieved from the first harvest onward.

The sequence of pictures that follows exemplifies the efficiency of prickly pear intensive-cultivation technology applied at Logradouro, Malhada farm, located on the Curimataú region in Paraíba, Brazil, from February 2006 to March 2007 (13 months). The plot used was planted with 0.5 ha of *Opuntia* and 0.5 ha of *Nopalea* and harvested 102 loads at the Opuntia side and 83 loads of Nopalea with 3 tons each; therefore, reaching the following data: 612 tons per hectare of *Opuntia* sp. (67.44 ton dry matter) and 498 tons per hectare of *Nopalea* sp. (73.00 ton dry matter) with an annual average precipitation of 800 mm (data collected through local pluviometer).

PICTURE Nº. 36
PLANTATION (1 Month)

PICTURE Nº. 37
PLANTATION (2 Months)

PICTURE Nº. 38
PLANTATION (3 Months)

PICTURE Nº. 39
PLANTATION (4 Months)

PICTURE Nº. 40
PLANTATION (5 Months)

PICTURE Nº. 41
PLANTATION (6 Months)

PICTURE Nº. 42
PLANTATION (7 Months)

PICTURE Nº. 43
PLANTATION (8 Months)

PICTURE Nº. 44
PLANTATION (9 Months)

PICTURE Nº. 45
PLANTATION (10 Months)

PICTURE Nº. 46
PLANTATION (11 Months)

PICTURE Nº. 47
PLANTATION (12 Months)

PICTURE Nº. 48
PLANTATION (13 Months)

3 – COSTS

Analysis

Implantation costs for each hectare following prickly pear intensive cultivation technology may vary according to the system to be used (Bilateral System or Cladode Superposition), soil type, and the way weeding is performed (manually or using herbicides) – Tables 2, 3, 4, and 5.

Here is shown the relation of cost and benefit from *Opuntia* sp. field implanted at Juazeirinho, located at Paraíba, Brazil, region of Seridó, where 490 tons per hectare (58.8 tons dry matter) were harvested in a period of 16 months with an annual average precipitation of 600 mm.

* **Soil Type**: Sandy
* **Soil Preparation**: Mechanized
* **Planting System Used**: Bilateral (Domino) with 60,000 cladodes.
*** Weed Control System**: Preemergent herbicide (Ametryne) and postemergent herbicide (Glyphosate).

PRICKLY PEAR INTENSIVE CULTIVATION TECHNOLOGY
JUAZEIRINHO – PARAÍBA – BRAZIL
Implantation costs to 1 ha – *Opuntia* sp.
BILATERAL SYSTEM (DOMINO) – 60,000 PLANTS PER HECTARE
SANDY SOIL WITH HERBICIDE APPLIED

ACTIVITY DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (R$)	UNIT PRICE (US$)	TOTAL COST (R$)	TOTAL COST (US$)
SOIL ANALYSIS MATTER						
SOIL SAMPLE	Sample	1	45.00	25.20	45.00	25.20
SOIL SET UP						
SUBSOLATION	Hrs/Machinery	6	50.00	28.00	300.00	168.00
FURROWING	Hrs/Machinery	2	50.00	28.00	100.00	56.00
VEGETATIVE MATTER TO PLANTING PROCEDURES						
PRICKLY PEAR CLADODE	Thousands	60	35.00	19.60	2,100.00	1,176.00
FERTILIZATION						
SIMPLE SUPERPHOSPHATE	kg	1,200	0.79	0.44	958.00	530.88
UREA	kg	600	1.17	0.66	702.00	393.12
ANIMAL FERTILIZER (DUNG)	Tons	15	40.00	22.40	600.00	336.00
AGRICULTURAL DEFENSIVES						
AMETRYNE	litre	4	10.00	5.60	40.00	22.40
GLYPHOSATE	litre	2	11.00	6.16	22.00	12.32
INSETICIDE	litre	1	13.00	7.28	13.00	7.28
ANT POISON	kg	2	8.00	4.48	16.00	8.96
HUMAN LABOR COSTS						
FERTILIZATION	Employee/Daily	8	14.00	7.84	112.00	62.72
PLANTING	Employee/Daily	40	14.00	7.84	560.00	313.60
DEFENSIVE APLIANCES	Employee/Daily	12	14.00	7.84	168.00	94.08
HARVESTING/TUMBLING	Employee/Daily	40	14.00	7.84	560.00	313.60
TOTAL					**6,286.00**	**3,520.16**

As observed, implantation costs for each hectare was R$6,286.00 or US$3,520.16.

At the end of the harvesting process, prickly pear supplied 490 tons that were put onto the market with an average unit cost of R$30.00 or US$16.67, totaling R$14,700.00 or US$8,168.30.

During the first planting year, a profit margin of R$8,414.00 or US$4,648.14 per hectare was achieved. From the second year onward, profit margin will increase significantly as expenses such as soil preparation and planting no longer exists.

NOTE: US$1.00 = R$1. 80 (January 2008)

4 - DISCUSSION

The biomass productivity for *Opuntia ficus-indica* in this paper is very high. This shows that by eliminating weed competition and by eliminating nutrient limitations, the very high water use

efficiency of *Opuntia* [162 kg water/kg dry matter (Han and Felker, 1997)] can be fully utilized. Simulations (Garcia de Cortazar and Nobel, 1990) under natural conditions led to a maximum predicted productivity of about 20 tons per hectare per year worldwide. Measurements with no water limitations gave 40 tons per hectare per year in Chile (Garcia de Cortazar and Nobel, 1991). A very high density planting (24 plants per meter squared) with unlimited water and ample nutrients led to 50 tons per hectare per year in Chile (Garcia de Cortazar and Nobel, 1992). And *O. ficus-indic*a watered and fertilized daily had a productivity of 47 tons per hectare per year in Mexico (Nobel et al., 1992). With high N and P applications in Texas to *Opuntia lindheimerii*, Gonzalez (1989) obtained 62 dry tons ha^{-1} yr^{-1}, which is comparable to the results presented here.

5 - FINAL CONSIDERATIONS

Prickly Pear Intensive Cultivation Technology (PPICT) has been developed by Paulo Suassuna since his return from a research visit to México and U.S.A. during 1994. Since then, the system has been improved each year with the objective of minimizing production costs and environmental impacts, as well as increasing prickly pear plantation productivity, making possible the development and sustenance of small rural properties located in the Brazilian semiarid region.

It is the author's opinion that the producer, having decided to apply PPICT, must not be afraid of the large planting costs and not follow the procedure in its entirety.

A fact is that from now on, producers must considered prickly pear as noble culture and, for that reason, special care must be given to it so as to guarantee its development, and also, must have the exact perception that prickly pear must not be considered only as a nourishment resource to be used only during drought periods. For its nutritional characteristics and the need to have a good culture handling, prickly pear could be given to livestock routinely.

With annual productivity levels that exceed 10 to 12 times the region's average, small rural properties are secured. Following prickly pear intensive cultivation directives, the small producer may supply forage for 20 to 30 dairy cows or 200 to 300 dairy goats or ewes throughout the year.

These approximate numbers (amounts) represent the benefits that the producer may reach by adopting Prickly Pear Intensive Cultivation Technology.

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TABLE 1

Data provided by:
UNIVERSIDADE FEDERAL DE CAMPINA GRANDE
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NUTRIENTS	*Opuntia* sp.		*Nopalea* sp.	
	DM	**MM**	**DM**	**MM**
Dry Matter	100.00	11.02	100.00	14.66
Organic Matter	-	-	-	-
Crude Protein	9.22	1.02	5,65	0,62
Neutral Detergent Fiber	-	-	-	-
Acid Detergent Fiber	-	-	-	-
Hemicellulose	-	-	-	-
Ether Extract	-	-	-	-
Gross Energy (Mcal/kg)	3.726	0.410	3.855	0.425
Mineral Matter	-	-	-	-
Phosphorus	-	-	-	-
Calcium	-	-	-	-
DIVMS	-	-	-	-

By UFCG – Patos.

TABLE 2

PRICKLY PEAR INTENSIVE CULTIVATION TECHNOLOGY
Implantation costs for 1 ha – *Opuntia* sp.
BILATERAL SYSTEM (DOMINO) – 60,000 PLANTS PER HECTARE
HEAVY SOIL WITH HERBICIDE APPLIANCE

ACTIVITY DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (R$)	UNIT PRICE (US$)	TOTAL COST (R$)	TOTAL COST (US$)
SOIL ANALYSIS MATTER						
SOIL SAMPLE	Sample	1	45.00	25.20	45.00	25.20
SOIL SET UP						
SUBSOLATION	Hrs/Machinery	8	50.00	28.00	400.00	224.00
HARROWING	Hrs/Machinery	2	50.00	28.00	100.00	56.00
FURROWING	Hrs/Machinery	3	50.00	28.00	150.00	84.00
VEGETATIVE MATTER TO PLANTING PROCEDURES						
PRICKLY PEAR CLADODE	Thousands	60	35.00	19.60	2,100.00	1,176.00
FERTILIZATION						
SIMPLE SUPERPHOSPHATE	kg	1,200	0.79	0.44	958.00	530.88
UREA	kg	500	1.17	0.66	585.00	327.60
ANIMAL FERTILIZER (DUNG)	Tons	15	40.00	22.40	600.00	336.00
AGRICULTURAL DEFENSIVES						
AMETRYNE	litre	4	10.00	5.60	40.00	22.40
GLYPHOSATE	litre	2	11.00	6.16	22.00	12.32
INSETICIDE	litre	1	13.00	7.28	13.00	7.28
ANT POISON	kg	2	8.00	4.48	16.00	8.96
HUMAN LABOR COSTS						
FERTILIZATION	Employee/Daily	8	14.00	7.84	112.00	62.72
PLANTING	Employee/Daily	55	14.00	7.84	770.00	431.20
DEFENSIVE APLIANCES	Employee/Daily	12	14.00	7.84	168.00	94.08
HARVESTING/TUMBLING	Employee/Daily	40	14.00	7.84	560.00	313.60
TOTAL					**6,629.00**	**3,712.24**

TABLE 3

PRICKLY PEAR INTENSIVE CULTIVATION TECHNOLOGY
Implantation costs for 1 ha – *Opuntia* sp.
BILATERAL SYSTEM (DOMINO) – 60,000 PLANTS PER HECTARE
SANDY SOIL WITH HERBICIDE APPLIANCE

ACTIVITY DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (R$)	UNIT PRICE (US$)	TOTAL COST (R$)	TOTAL COST (US$)
SOIL ANALYSIS MATTER						
SOIL SAMPLE	Sample	1	45.00	25.20	45.00	25.20
SOIL SET UP						
SUBSOLATION	Hrs/Machinery	6	50.00	28.00	300.00	168.00
FURROWING	Hrs/Machinery	2	50.00	28.00	100.00	56.00
VEGETATIVE MATTER TO PLANTING PROCEDURES						
PRICKLY PEAR CLADODE	Thousands	60	35.00	19.60	2,100.00	1,176.00
FERTILIZATION						
SIMPLE SUPERPHOSPHATE	kg	1,200	0.79	0.44	958.00	530.88
UREA	kg	600	1.17	0.66	702.00	393.12
ANIMAL FERTILIZER (DUNG)	Tons	15	40.00	22.40	600.00	336.00
AGRICULTURAL DEFENSIVES						
AMETRYNE	litre	4	10.00	5.60	40.00	22.40
GLYPHOSATE	litre	2	11.00	6.16	22.00	12.32
INSETICIDE	litre	1	13.00	7.28	13.00	7.28
ANT POISON	kg	2	8.00	4.48	16.00	8.96
HUMAN LABOR COSTS						
FERTILIZATION	Employee/Daily	8	14.00	7.84	112.00	62.72
PLANTING	Employee/Daily	40	14.00	7.84	560.00	313.60
DEFENSIVE APLIANCES	Employee/Daily	12	14.00	7.84	168.00	94.08
HARVESTING/TUMBLING	Employee/Daily	40	14.00	7.84	560.00	313.60
TOTAL					**6,286.00**	**3,520.16**

TABLE 4

PRICKLY PEAR INTENSIVE CULTIVATION TECHNOLOGY
Implantation costs for 1 ha – *Opuntia* sp.
CLADODE SUPERPOSITION (DECK OF CARDS) – 60,000 PLANTS PER HECTARE
HEAVY SOIL WITH HERBICIDE APPLIANCE

ACTIVITY DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (R$)	UNIT PRICE (US$)	TOTAL COST (R$)	TOTAL COST (US$)
SOIL ANALYSIS MATTER						
SOIL SAMPLE	Sample	1	45.00	25.20	45.00	25.20
SOIL SET UP						
SUBSOLATION	Hrs/Machinery	8	50.00	28.00	400.00	224.00
HARROWING	Hrs/Machinery	2	50.00	28.00	100.00	56.00
FURROWING	Hrs/Machinery	3	50.00	28.00	150.00	84.00
VEGETATIVE MATTER TO PLANTING PROCEDURES						
PRICKLY PEAR CLADODE	Thousands	60	35.00	19.60	2,100.00	1,176.00
FERTILIZATION						
SIMPLE SUPERPHOSPHATE	kg	1,200	0.79	0.44	958.00	530.88
UREA	kg	500	1.17	0.66	585.00	327.60
ANIMAL FERTILIZER (DUNG)	Tons	15	40.00	22.40	600.00	336.00
AGRICULTURAL DEFENSIVES						
AMETRYNE	litre	4	10.00	5.60	40.00	22.40
GLYPHOSATE	litre	2	11.00	6.16	22.00	12.32
INSETICIDE	litre	1	13.00	7.28	13.00	7.28
ANT POISON	kg	2	8.00	4.48	16.00	8.96
HUMAN LABOR COSTS						
FERTILIZATION	Employee/Daily	8	14.00	7.84	112.00	62.72
PLANTING	Employee/Daily	20	14.00	7.84	280.00	156.80
DEFENSIVE APLIANCES	Employee/Daily	12	14.00	7.84	168.00	94.08
HARVESTING/TUMBLING	Employee/Daily	40	14.00	7.84	560.00	313.60
TOTAL					**6,139.00**	**3,437.84**

TABLE 5

PRICKLY PEAR INTENSIVE CULTIVATION TECHNOLOGY
Implantation costs for 1 ha – *Opuntiae* sp.
CLADODE SUPERPOSITION (DECK OF CARDS) – 60,000 PLANTS PER HECTARE
LIGHT SOIL WITH HERBICIDE APPLIANCE

ACTIVITY DESCRIPTION	UNIT	QUANTITY	UNIT PRICE (R$)	UNIT PRICE (US$)	TOTAL COST (R$)	TOTAL COST (US$)
SOIL ANALYSIS MATTER						
SOIL SAMPLE	Sample	1	45.00	25.20	45.00	25.20
SOIL SET UP						
SUBSOLATION	Hrs/Machinery	6	50.00	28.00	300.00	168.00
FURROWING	Hrs/Machinery	2	50.00	28.00	100.00	56.00
VEGETATIVE MATTER TO PLANTING PROCEDURES						
PRICKLY PEAR CLADODE	Thousands	60	35.00	19.60	2,100.00	1,176.00
FERTILIZATION						
SIMPLE SUPERPHOSPHATE	kg	1,200	0.79	0.44	958.00	530.88
UREA	kg	600	1.17	0.66	702.00	393.12
ANIMAL FERTILIZER (DUNG)	Tons	15	40.00	22.40	600.00	336.00
AGRICULTURAL DEFENSIVES						
AMETRYNE	litre	4	10.00	5.60	40.00	22.40
GLYPHOSATE	litre	2	11.00	6.16	22.00	12.32
INSETICIDE	litre	1	13.00	7.28	13.00	7.28
ANT POISON	kg	2	8.00	4.48	16.00	8.96
HUMAN LABOR COSTS						
FERTILIZATION	Employee/Daily	8	14.00	7.84	112.00	62.72
PLANTING	Employee/Daily	20	14.00	7.84	280.00	156.80
DEFENSIVE APLIANCES	Employee/Daily	12	14.00	7.84	168.00	94.08
HARVESTING/TUMBLING	Employee/Daily	40	14.00	7.84	560.00	313.60
TOTAL					**6,006.00**	**3,363.36**

PICTURE Nº. 1

PICTURE Nº. 4

PICTURE Nº. 2

PICTURE Nº. 5

PICTURE Nº. 3

PICTURE Nº. 6

PICTURE Nº. 7

PICTURE Nº. 10

PICTURE Nº. 8

PICTURE Nº. 11

PICTURE Nº. 9

PICTURE Nº. 12

PICTURE Nº. 13

PICTURE Nº. 16

PICTURE Nº. 14

PICTURE Nº. 17

PICTURE Nº. 15

PICTURE Nº. 18

PICTURE Nº. 19

PICTURE Nº. 22

PICTURE Nº. 20

PICTURE Nº. 23

PICTURE Nº. 21

PICTURE Nº. 24

PICTURE Nº. 25

PICTURE Nº. 28

PICTURE Nº. 26

PICTURE Nº. 29

PICTURE Nº. 27

PICTURE Nº. 30

PICTURE Nº. 31

PICTURE Nº. 34

PICTURE Nº. 32

PICTURE Nº. 35

PICTURE Nº. 33

PICTURE Nº. 36 - Plantation (1 month)

PICTURE Nº. 37 - Plantation (2 months)

PICTURE Nº. 40 - Plantation (5 months)

PICTURE Nº. 38 - Plantation (3 months)

PICTURE Nº. 41 - Plantation (6 months)

PICTURE Nº. 39 - Plantation (4 months)

PICTURE Nº. 42 - Plantation (7 months)

PICTURE Nº. 43 - Plantation (8 months)

PICTURE Nº. 44 - Plantation (9 months)

PICTURE Nº. 45 - Plantation (10 months)

PICTURE Nº. 46 - Plantation (11 months)

PICTURE Nº. 47 - Plantation (12 months)

PICTURE Nº. 48 - Plantation (13 months)