PRODUCTIVITY OF SILPHIUM PERFOLIATUM L. IN LOW INPUT AGRICULTURAL SYSTEMS

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ABSTRACT
There is a large area in the coastal region of southern Chile affected by low productivity of soils and severe climatic limitations, which is owned mainly by small farmers. This research was conducted with dairy farmers producing an average of 20,000 liters/year whose main problem is cattle underfeeding because of severe seasonal cycles in pasture growth and extended overgrazing of natural grasslands of low production potential. *Silphium perfoliatum* L. is a perennial forage species that grows well during the summer period when grasslands have stopped their growth due to moisture stress and high temperatures. Based on the agronomic results and direct on-farm research experience with small farmers, this new species was evaluated as a supplement for summer feeding of milking cows. It was found that a small surface sown with *Silphium perfoliatum* L. can increase milk production by almost 50% and that the ratio of marginal income to marginal cost is 3.5. It has low capital and labor requirements and the wide range of sites where it is adapted insures low production risk.

KEYWORDS
Silphium perfoliatum L., farming systems, forage, mediterranean climate, milk production

INTRODUCTION
There are in Chile approximately 150,000 small farmers located in the coastal region between parallels 37½ and 41½ in soils dominated by red clays with broken topography. The average farm size is 53 ha and their activity combines the cropping and livestock raising under natural pastures (Pichard & Gana, 1992). Some cereal production as well as home grown vegetables, poultry, swine and small ruminants are used for self-consumption but the majority of the farm products are sold in well established markets. Field labor is done mainly by the farmer and his family, and they rarely employ additional people. The yields of cereal crops are fairly low and consequently the net income of the farmer comes mainly from their livestock production.

The climate is mediterranean, alternating severe summer droughts and cold and wet winters. This imposes a marked seasonal pattern in pasture production which shows a short spring growth followed by a severe stress due to high temperature and low moisture during summer, then a brief autumn aftermath prior to the winter dormancy. In turn long periods of overgrazing occur and according with the calving season, periods of good and poor nutrition alternate in milking cows. The nutritional unbalance derives primarily from the low feed intake during stages of high physiological demand for nutrients.

Silphium perfoliatum L. is a perennial heliantaceae that can be regarded as a strategic forage resource for supplementing during the summer drought. This work was undertaken in order to evaluate the impact among small farmers of improving the feeding strategies during critical periods of the year by means of producing *Silphium perfoliatum* L. as a supplementary forage.

MATERIALS AND METHODS
Field experiments were conducted by the authors (Pichard et al., 1995) between 1989 and 1994 in farms of small peasants, located in southern Chile, using the "on-farm research" methodology (Zandstra et al., 1981 and Shaner et al., 1982). The measurements showed outstanding agronomic characteristics of *Silphium perfoliatum* L. in terms of adaptation, seasonal growth and dry matter yield, similar to those found by Niqueux (1981). The nutritional quality was sufficient to support the desired animal production levels. From a socio-economic point of view the capital requirement, labor intensity and risk involved were all well accepted by the target population.

In different farms soil pH varied from 5.0 to 5.4 and Olsen phosphorus from 6 to 14 ppm P_2O_5. Annual rainfall ranges between 830 and 1080 mm, monthly rainfall in summer season ranges from 0 to 174 mm whilst during winter month we observe 55% of the annual rainfall. Mean minimum and maximum temperatures in summer are 9.3½C and 28.5½C and in winter -1.6½C and 9.8½C respectively. Dry matter yield and chemical composition were dependent on the harvesting regime imposed. One single cut in late summer yielded 15 to 22 tons DM/ha of a stemmy forage with low protein (6 - 8%) and low digestibility (60 - 64%). However, the authors have recommended to cut several times in the growing season and to establish a sequential and progressive cutting program such that sectors first cut can be used again for a second cut upon finishing the harvest of the total area. Under a multiple cutting regime, the first cut begins in mid spring and continues until early summer; the yield is 6 to 10 tons DM/ha with high leaf/stem ratio, 12-15% crude protein and 70-80% digestibility. The aftermath cut begins in early summer and it yields a similar quantity with protein and digestibility values slightly lower than the first cut. In areas with longer growing season a third growth can be utilized in late summer or early autumn. Its yield is only 2-3 tons DM/ha with high protein and digestibility values.

Regarding the production systems of the area under study the cropping surface varies from 2.0 to 50.5 ha, wheat and oat being the most important. Oats are harvested either as grain or as hay in late stages of development. Red clover is often sown with the cereal and kept productive for one year. 48.8 % of the surface is under natural pasture dominated by *Agrostis tenuis, Holcus lanatus, Hypochoeris radicata, Lotus uliginosus, Bromus unioloides, Plantago lanceolata and Taraxacum oficinale*. The average herd size is 10 milking cows plus their corresponding heifers, steers and calves; the stocking rate varies from 0.1 to 1.0 cow/ha/year, average annual milk production is close to 20,000 liters/farm and lactation curves vary according with calving season.

The overall operational costs (Chilean Pesos) of a typical small farm ranges from $1,086,000.- and $2,330,000.- which includes cash expenses in the range of $533,750.- to $2,020,000.- plus their own labor and the use of their own machinery. The gross income of small farmers, ranges from $2,090,000.- to $5,393,000.- being zero to 30% derived from cropping and the rest from livestock. The net income ranges from $1,262,000.- to $2,300,000.- which is used primarily for family expenses and little is saved for the coming year capital requirement.

RESULTS AND DISCUSSION
The cost of establishing one hectare of *Silphium perfoliatum* L. is approximately $211,000.- which corresponds to 10 to 18 % of the net income of the farmer. In order to split this amount it is recommended that sowing be done along four years (See table 1). In average farm sizes, once the steady state is reached, the forage yield of Silphium contributes with additional 10.3% and 181% to spring and summer forage production respectively (Table 2). Its average crude protein and metabolizable energy are 12.5% and 2.5 Mcal/Kg DM respectively. When consumed only by milking cows we find a significant increase in voluntary intake beyond the basal consumption that supports maintenance plus some milk production. Such supplementation is primarily converted to animal product, being milk rather than body weight because body condition has been recovered in early and mid spring. This means that the dairy herd supplemented during 120 days would increase milk output by 8.800 liters assuming that only 50% of the supplementary metabolizable energy consumed is used for milk production. The figures in Table 1 show a large economic impact of this supplementation, being the marginal in-

come 3.5 times the marginal costs involved in this technology. Other benefits should be pointed out like reducing overgrazing of natural pastures thus improving dry matter production in the coming season and avoiding erosion risks.

It is concluded that *Silphium perfoliatum* L. is a perennial forage plant that can be adopted by small farmers with low capital and labor requirements. Its growth during summer and its low moisture requirement insure low production risk and a significant impact in milk yield and net income of small farmers.

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Table1

Economic evaluation for the establishment of one hectare of Silphium perfoliatum in a small dairy farm.

	YEAR					
	1	2	3	4	5	6 - 10
AREA AND YIELD						
Annual area (ha)	0.25	0.25	0.25	0.25	-	-
Cumulative area (ha)	0.25	0.5	0.75	1.00	1.00	1.00
Productive area (ha)	0	0.25	0.5	0.75	1.00	1.00
Forage yield (tons DM/ha)	0	2.4	4.8	7.2	9.6	9.6
ESTABLISHMENT COST (Ch$/000)	52.9	52.9	52.9	52.9	-	-
PRODUCTIVE COSTS (Ch$/000)						
Allocation of establishment cost	-	5.3	10.6	15.9	21.2	21.2
Management	26.5	52.9	78.2	104.7	104.7	104.7
Harvest	-	9.2	18.4	21.2	36.8	36.8
Subtotal direct cost	26.5	67.4	107.2	141.7	162.6	162.6
Alternative cost of land	18.4	36.8	55.1	73.5	73.5	73.5
Total direct cost	44.8	104.1	162.3	215.2	236.1	236.1
Cash expenses	15.6	42.5	67.5	89.3	107.3	81.0
Non cash costs	29.2	61.7	94.8	125.9	128.8	155.1
MILK PRODUCTION POTENTIAL						
ME (Mcal/kg DM)	2.2	2.2	2.2	2.2	2.2	2.2
Yield ME/ha (Mcal/ha)	0	5,280	10,560	15,840	21,120	21,120
ME available for milk (50%)	0	2,640	5,280	7,920	10,560	10,560
Milk production potential (lts)	0	2,200	4,400	6,600	8,800	8,800
ECONOMIC IMPACT (Ch$/000)						
Cost	44.8	104.1	162.3	215.2	236.1	236.1
Income	0.0	209.0	418.0	627.0	836.0	836.0
Benefit	-44.8	104.9	255.7	411.8	599.9	599.9
Income/Cost ratio	0.00	2.01	2.58	2.91	3.54	3.54
NPV (Net present value, i=10%, 10 years, Ch$/000						2,136
IRR (Internal rate of return)						**154%**

Table 2

Seasonal impact of one hectare of Silphium perfoliatum on forage and milk production in a 20 ha and 9 cows farm. A case study.

		No Silphium (20 has)	**With Silphium** (20 has)	**Difference**
LAND USE (ha)	Natural grasslands	19.1	18.1	-
	Red clover	0.9	0.9	-
	Silphium perfoliatum	0.0	1.0	-
FORAGE PRODUCTION (kg DM/ha)				
Winter		2,941	2,787	-154
Total		46,520	53,920	7,400
MILK PRODUCTION * (lts/year)				
Winter		1,800	1,800	0
Spring		12,600	15,240	2,640
Summer		3,600	9,760	6,160
Autumn		0	0	0
Total		18,000	26,800	8,800

* Late winter calving