Lupinus albus performs as the species that allows greatest grain and protein yields in Chile

Lupinus albus se evidencia como la especie que logra mayores rendimientos de grano y proteína en Chile

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Ministerio de Agricultura
Gobierno de Chile

CHILE LO HACEMOS TODOS

Lupin in Chile concentrates (>90%) in Araucanía region

Crop rotations in southern Chile are heavily based on cereals and a legume crop is badly needed

Area sown with lupins fluctuates in the range 20.000-30.000 hectares, under rainfed conditions, with an average yield of 2500 kg/ha

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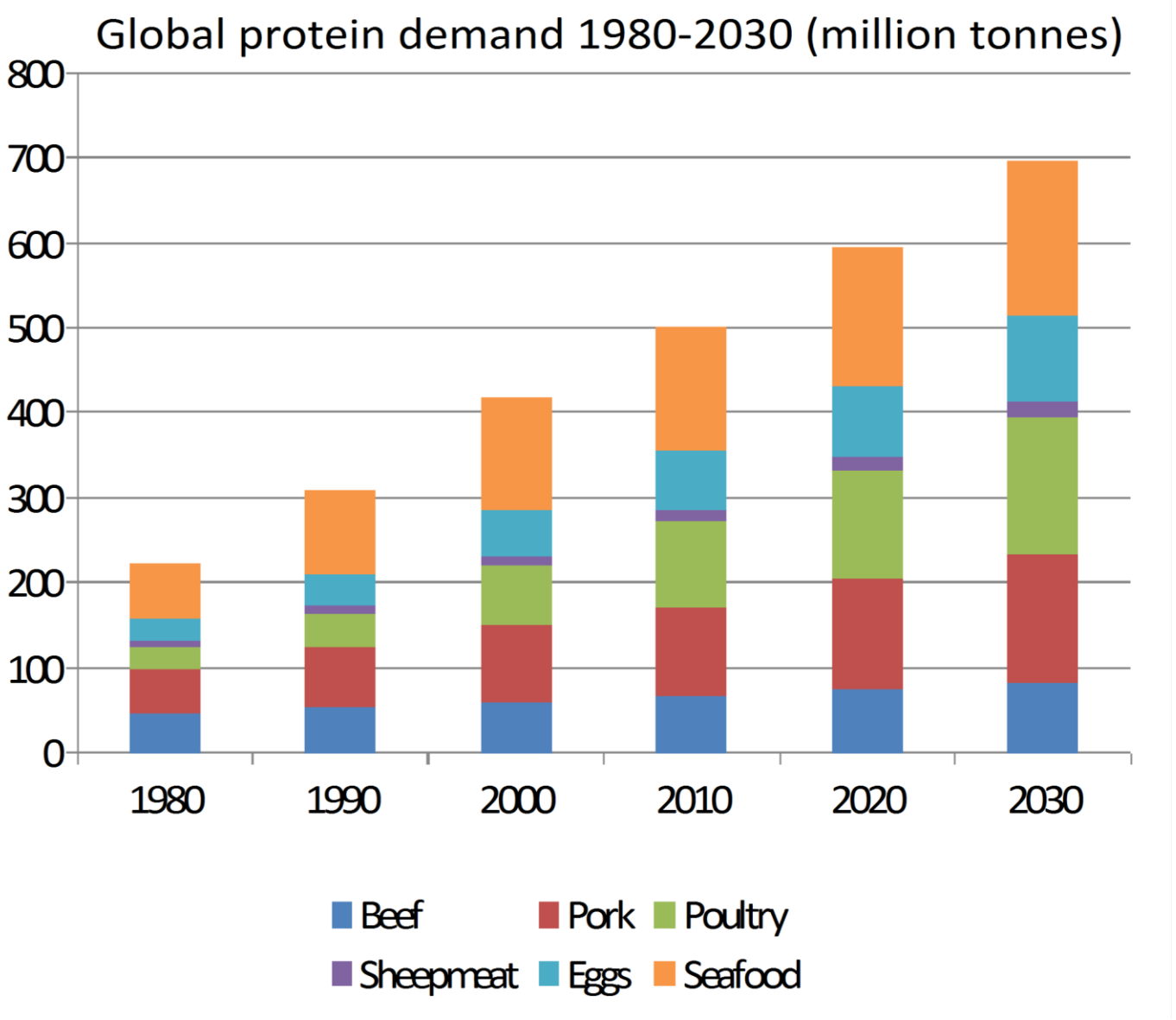
Current uses of sweet lupins produced in Chile

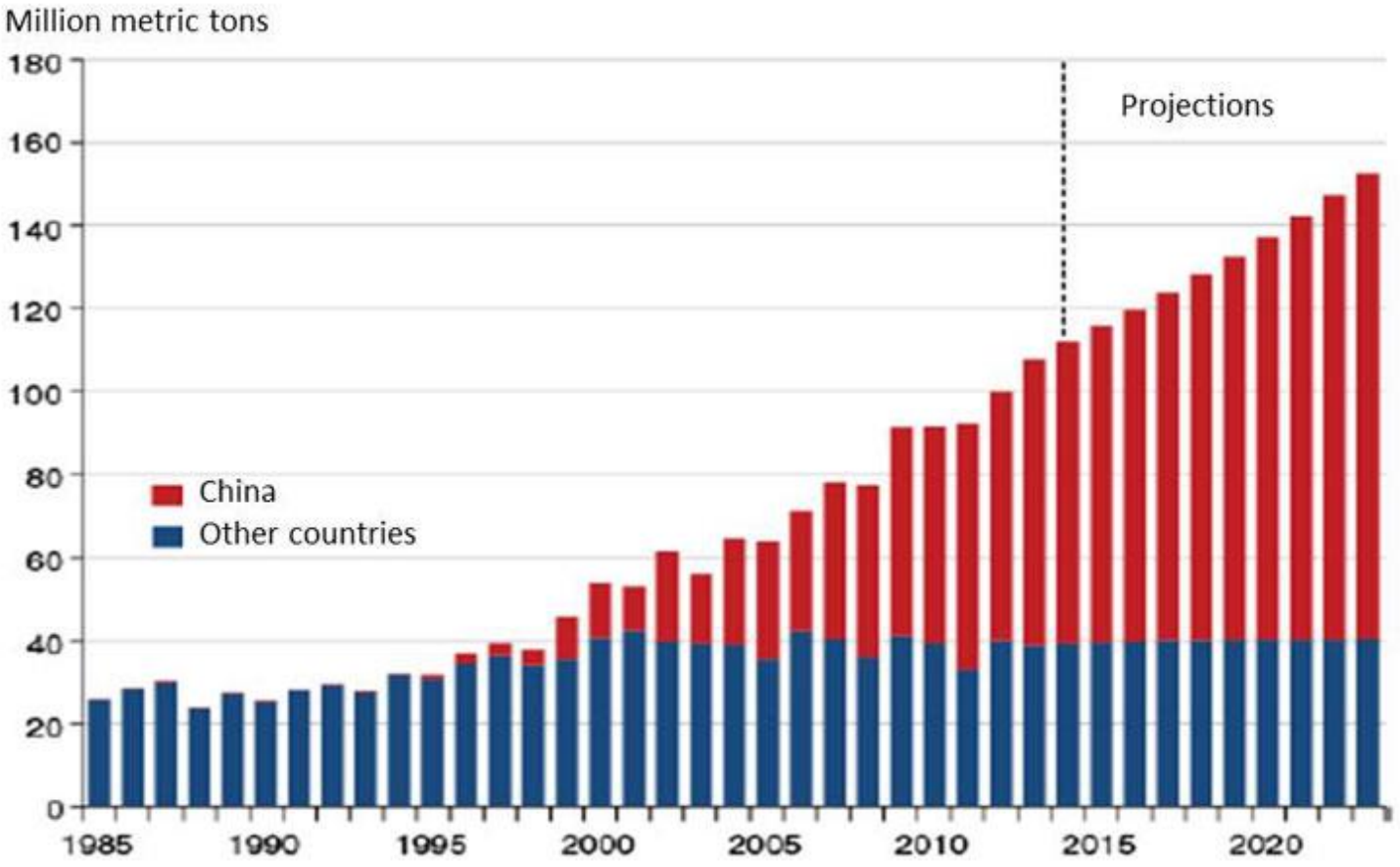
Lupins compete with imported plant protein, mainly soybean meal

Use for human consumption is relatively small, for now



Source: Lumb, Stuart. ANPARIO Conference “Solutions to sustainable modern livestock production”, London, 2015.

China will continue to be dominant global soybean importer

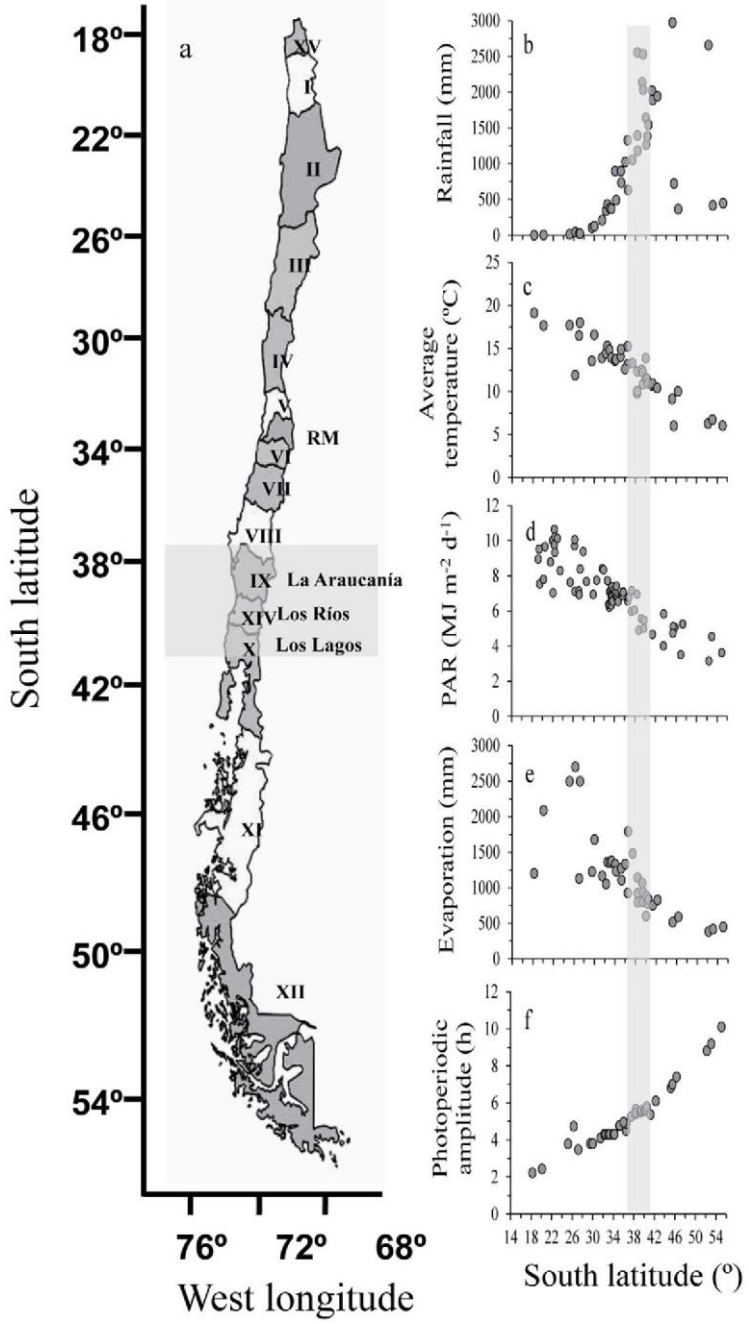


Source: USDA Production, Supply and Distribution database and projections

Access to affordable soybean has uncertain future and lupins may provide protein at a competitive price

Southern Chile is considered one of the environments with high yield potential in the world

For top farmers, wheat yields over 10 Mg ha^{-1} are not unusual



(a) map of Chile, (b) rainfall, (c) annual average temperature, (d) annual average photosynthetic active radiation (PAr), (e) cumulative pan evaporation and (f) photoperiod amplitude across the latitudes of Chile.

Source: Mera M. et al. 2014. In Sadras VO & Calderini DF (eds) Crop Physiology, Applications for genetic improvement and agronomy, 2nd ed.

Species available for sweet lupin production in Chile

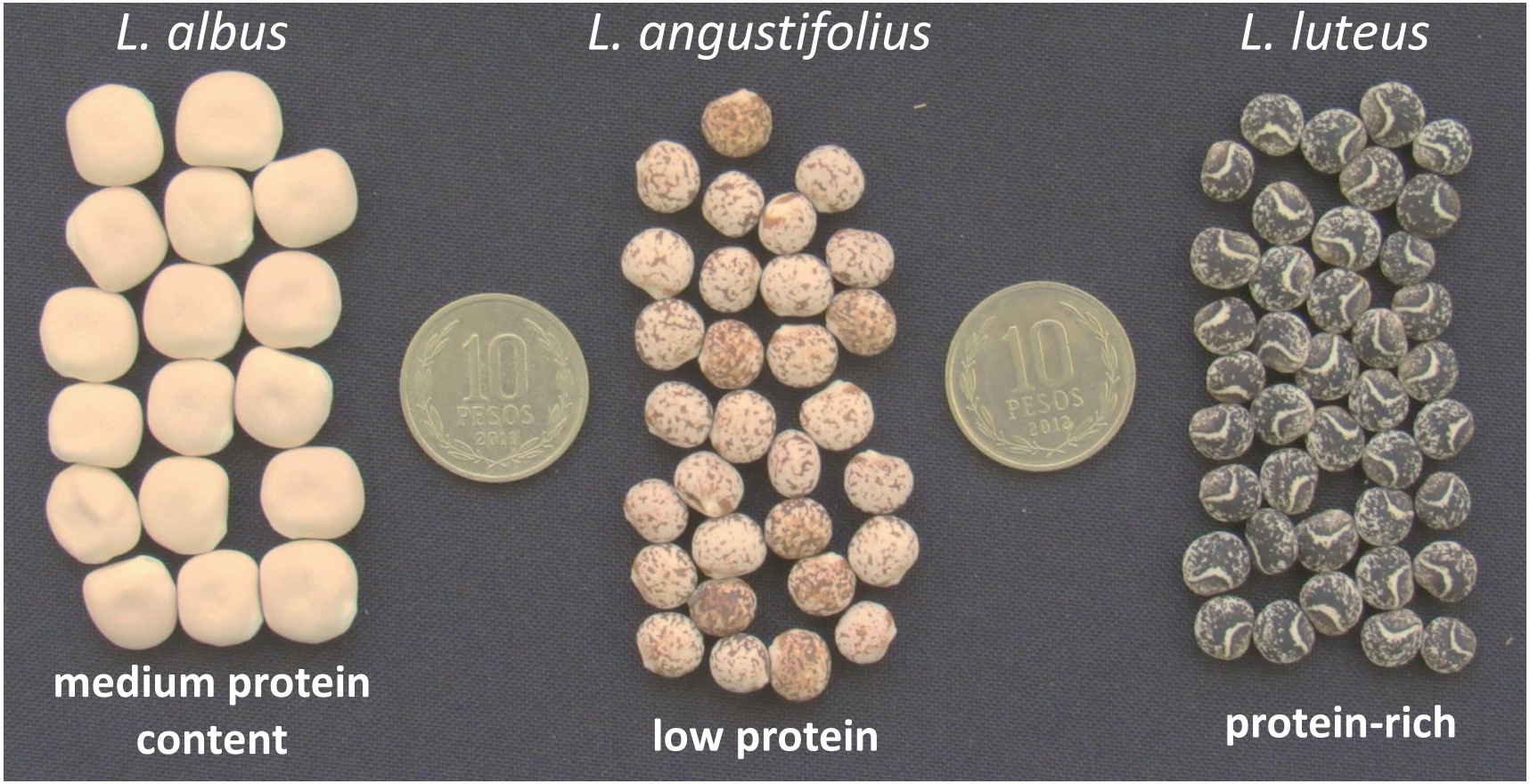
Lupinus albus

Lupinus angustifolius

Lupinus luteus

The majority of the lupin area is sown with *L. albus*

Mediterranean lupin species



What species produces the greatest protein yields?

Objective

- To gather data comparing three Mediterranean lupin species as grain and protein producers

- This information is valuable to establish realistic economic scenarios for farmers and sensible allocation of resources for R&D

Genetic material

Available to farmers or with good behavior in trials

Species	Cultivar/line	Origin
L. albus all autumn-sowing	Alboroto-INIA	Chile
	Rumbo-Baer	Chile
	IT-34	Chile
	Clovis (Jouffray-Drillaud)	France
L. angustifolius	Lila-Baer	Chile
	PMG-1609	Chile
	Merrit (DAFWA)	Australia
L. luteus	Aluprot-CGNA	Chile
	Mister (Poznan Plant Breeders)	Poland

4 locations

2 sowing times

autumn

winter

2 years

2015-16

2016-17

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Methods

Design	RCB combined over locations and years, reps (4) nested within sites (sowing times analyzed separately)
Plots	5 rows, 5 m long, 0.35 m apart 3 central rows were harvested
Treatments	Cultivars/lines and usual management for the species

Species	Seed rate
L. albus	35 seeds m^{-2}
L. angustifolius	55 seeds m^{-2}
L. luteus	90 seeds m^{-2}

Victoria, November 2015

Farm:
Alfredo &
Pablo Ruff

Lautaro, November 2015

Lautaro, November 2016

Imperial, November 2016

Results

Results

Grain yield, means across locations, 2015

Species	Cultivar/line	Autumn kg ha^{-1}	Winter kg ha^{-1}
L. albus	Alboroto-INIA	4829	3640
	Rumbo-Baer	4437	3066
	IT-34	4224	3079
	Clovis	3910	2603
L. angustifolius	Lila-Baer	BYMV-N	BYMV-N
	PMG-1609	BYMV-N	BYMV-N
	Merrit	BYMV-N	BYMV-N
L. luteus	Aluprot-CGNA	2135	2214
	Mister	1895	1727

Results

Grain yield, means across locations, 2016

Species	Cultivar/line	Autumn kg ha^{-1}	Winter kg ha^{-1}
L. albus	Alboroto-INIA	5696	5650
	Rumbo-Baer	6013	4988
	IT-34	6221	5563
	Clovis	4667	4035
L. angustifolius	Lila-Baer	3683	3448
	PMG-1609	3861	4283
	Merrit	3971	3858
L. luteus	Aluprot-CGNA	3161	2914
	Mister	3431	3000

Results

Protein content, means across locations, 2015

Species	Cultivar/line	Autumn % of DM	Winter % of DM
L. albus	Alboroto-INIA	36.6	33.5
	Rumbo-Baer	35.7	35.6
	IT-34	33.9	32.0
	Clovis	30.6	29.9
L. angustifolius	Lila-Baer	BYMV-N	BYMV-N
	PMG-1609	BYMV-N	BYMV-N
	Merrit	BYMV-N	BYMV-N
L. luteus	Aluprot-CGNA	41.1	40.5
	Mister	38.1	39.9

Results

Protein content, means across locations, 2016

Species	Cultivar/line	Autumn % of DM	Winter % of DM
L. albus	Alboroto-INIA	33.6	33.2
	Rumbo-Baer	35.7	34.8
	IT-34	33.1	35.0
	Clovis	30.4	31.6
L. angustifolius	Lila-Baer	28.2	31.0
	PMG-1609	25.7	28.2
	Merrit	29.8	30.9
L. luteus	Aluprot-CGNA	40.8	44.1
	Mister	41.4	42.6

Results

Protein yield, means across locations, 2015

Species	Cultivar/line	Autumn kg ha^{-1}	Winter kg ha^{-1}
L. albus	Alboroto-INIA	1554	1060
	Rumbo-Baer	1368	936
	IT-34	1239	839
	Clovis	1036	662
L. angustifolius	Lila-Baer	BYMV-N	BYMV-N
	PMG-1609	BYMV-N	BYMV-N
	Merrit	BYMV-N	BYMV-N
L. luteus	Aluprot-CGNA	746	773
	Mister	618	586

Results

Protein yield, means across locations, 2016

Species	Cultivar/line	Autumn kg ha^{-1}	Winter kg ha^{-1}
L. albus	Alboroto-INIA	1693	1622
	Rumbo-Baer	1870	1490
	IT-34	1812	1698
	Clovis	1245	1105
L. angustifolius	Lila-Baer	859	915
	PMG-1609	851	1037
	Merrit	1035	1024
L. luteus	Aluprot-CGNA	1111	1098
	Mister	1215	1097

Analysis
Grain yield

- In order to analyze data from two years, *L. angustifolius* was excluded

Source	DF	Autumn sowing time Mean squares	Winter sowing time Mean squares
Year (Y)	1	86847555**	128627181**
Location (L)	3	42549108**	34717133**
L x Y	3	23586617**	5004543**
Reps [L]	12	1656677**	757348**
Material (M)	5	49261797**	28512955**
M x Y	5	1581940**	3187278**
M x L	15	1550262**	1675605**
M x L x Y	15	1285548**	998907**
Error	132	475431	292395
CV		**16.4%**	**15.3%**

Results

Grain yield, means across locations and years

Species	Cultivar/line	Autumn kg ha^{-1}		Winter kg ha^{-1}	
L. albus	Alboroto-INIA	5107	a	4645	a
	Rumbo-Baer	5225	a	4027	b
	IT-34	5223	a	4321	ab
	Clovis	4289	b	3319	c
L. luteus	Aluprot-CGNA	2648	c	2564	d
	Mister	2663	c	2364	d

Levels not connected by same letter are significantly different according to Tukey HSD test with alpha = 0.05

Results

Protein yields, means across locations and years, with autumn sowing

Species	Cultivar/line	Yield kg ha^{-1}	Protein content % DM	Protein yield kg ha^{-1}
L. albus	Alboroto-INIA	5107	36.6	**1645**
	Rumbo-Baer	5225	35.7	**1641**
	IT-34	5223	33.9	1558
	Clovis	4289	30.6	1155
L. luteus	Aluprot-CGNA	2648	40.8	951
	Mister	2663	41.4	970

Conclusions

- With the genetic material available to date, *L. albus* appears as the best option to produce protein in Chile
- *L. angustifolius* showed yield and protein content lower than *L. albus*
- *L. luteus* accumulated nearly 7 percent points more protein than *L. albus*, but reached 53% of *L. albus* yield
- The protein yield of the *L. luteus* cultivars was 58% of that achieved by the two best *L. albus* cultivars

- Autumn sowing was more favorable than winter sowing for *L. albus* materials, whereas the yields of *L. angustifolius* and *L. luteus* were virtually unaffected by sowing time

Thanks for your attention

Grain yield by location
Autumn sowing 2015

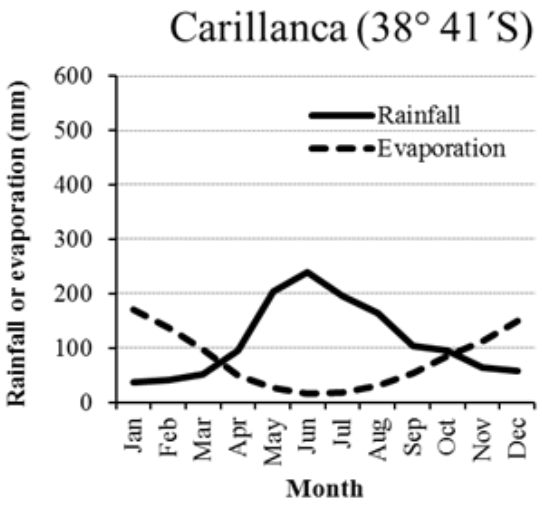
Species	Cultivar/line	Victoria kg ha^{-1}	Lautaro kg ha^{-1}	Imperial kg ha^{-1}	Mafil kg ha^{-1}
L. albus	Alboroto-INIA	3549	5600	3673	6495
	Rumbo-Baer	4187	4739	3722	5099
L. angustifolius	Lila-Baer	BYMV-N	BYMV-N	BYMV-N	BYMV-N
	Merrit	BYMV-N	BYMV-N	BYMV-N	BYMV-N
L. luteus	Aluprot-CGNA	1683	1972	1738	3147
	Mister	1563	2108	1101	2810

Victoria, Imperial: sites with soil compaction, acidity and very limited available phosphorus (< 5 ppm Olsen)

Grain yield by location
Autumn sowing 2016

Species	Cultivar/line	Victoria kg ha^{-1}	Lautaro kg ha^{-1}	Imperial kg ha^{-1}	Mafil kg ha^{-1}
L. albus	Alboroto-INIA	2221	5526	7127	7912
	Rumbo-Baer	3969	5534	7310	7240
L. angustifolius	Lila-Baer	2776	4027	3319	4611
	Merrit	2602	4411	3712	5157
L. luteus	Aluprot-CGNA	2440	2980	3758	3465
	Mister	2412	3219	3806	4286

Victoria: site with soil compaction, acidity and very limited available phosphorus (< 5 ppm Olsen)


Carillanca (38° 41´S)
Rainfall or evaporation (mm)
600
500
400
300
200
100
0
Rainfall
Evaporation
Jan
Feb
Mar
Apr
May
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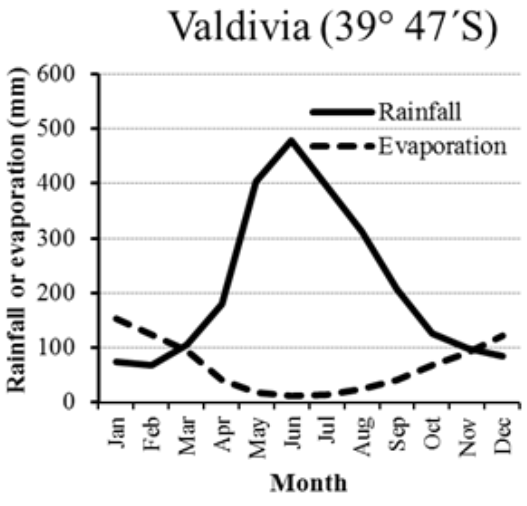
Nov
Dec
Month


Valdivia (39° 47´S)
Rainfall or evaporation (mm)
600
500
400
300
200
100
0
Rainfall
Evaporation
Jan
Feb
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May
Jun
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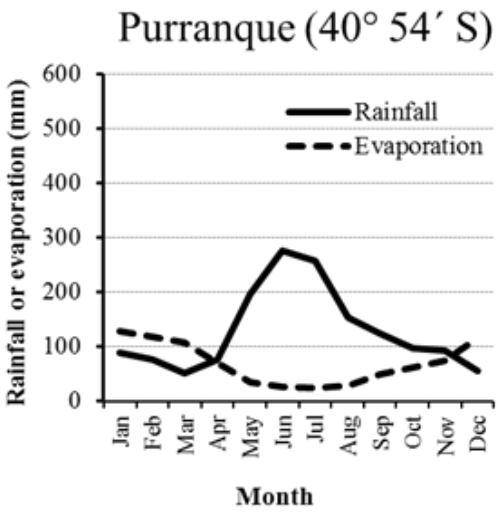
Purranque (40° 54´ S)
Rainfall or evaporation (mm)
600
500
400
300
200
100
0
Rainfall
Evaporation
Jan
Feb
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Dec
Month

Alboroto-INIA, sweet lupin cultivar

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Alboroto-INIA

compact architecture, easy-harvesting

Carillanca
Feb. 26
2014

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Results

Grain yield, means of locations

Across years

Considering cultivars of *L. albus* and *L. luteus*

Location	Autumn sowing kg ha^{-1}		Winter sowing kg ha^{-1}	
Mafil	5255	a	4156	a
Lautaro	4324	b	3317	b
Imperial	4228	b	4255	a
Victoria	2963	c	2431	c

Levels not connected by same letter are significantly different according to Tukey HSD test with alpha = 0.05