Bi-cropping spring field bean *(Vicia faba)* and wheat *(Triticum aestivum)* for UK wholecrop forage production

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Background

The advantage of cereals is the high level of carbohydrate content , but lower crude protein levels limits their suitability alone as wholecrop forage (Anil *et al.* 1998; Azo *et al.* 2012; Sadeghpour *et al.* 2013).

Bi-cropping can provide a much more nutritionally balanced complete forage (Jensen *et al.* 2010)

Aim

To assess the effects of spatial arrangements of bi-crop mixtures of wheat and beans with contrasting growth characteristics on ecological resource-use-efficiency and forage quality.

Materials and Methods

The study was conducted at the Royal Agricultural University (51° 42' 33.6" N 1° 59' 40.7" W) during Spring 2015. Two bean cultivars and four drilling patterns laid out as completely randomised block design with four replicates were evaluated. Sole and bi-crops of Paragon wheat variety, Fuego and Maris Bead bean cultivars (Table 2) were sown in a substitutive design structure (50:50). The site's soil textural class was clay of 20.25% Sand; 38.50% Silt and 41.25% Clay; with pH of 7.8 and 4.5% organic matter content.

Table 1: Monthly total rainfall (mm) and mean temperatures (°C) at Royal Agricultural University in 2015.

Months	Rainfall (mm)	Mean temperature (°C)	
		Minimum	Maximum
January	93.1	0.9	6.8
February	51.9	1.5	7.4
March	34.2	2.2	10.4
April	13.9	4.1	14.0
May	71.0	6.6	16.3
June	41.8	9.2	19.4
July	56.3	11.6	22.7
August	75.7	10.7	6.8

Table 2: Description of crop varieties

Spring crop	Hilum colour	Straw height index	Time to mature index	Protein content (%DM)	Year of release
Fuego bean	Pale	7	6	28.0	2005
Maris Bead bean	Black	6	5	29.6	1964
Paragon wheat	NA	5	6	13.7	1999

A scale of 1-9, a high figure indicates that the variety shows the character to a high degree.

Source: PGRO (2015)

Drilling patterns

- **1 x 1 -** One row of wheat bi-crop ***to*** one row of beans bi-crops in alternate row arrangement
- **2 x 2 -** Two rows of wheat bi-crop ***to*** two rows of beans bi-crop in alternate row arrangement
- **3 x 3** - Three rows of wheat bi-crop ***to*** three rows of beans bi-crops in alternate row arrangement
- **Broadcast** – Beans randomly sown in drilled wheat rows

Results and Discussion

Table 3: Chlorophyll content (CCI), light interception (%) crude protein (CP) levels and fodder quality influenced by cropping systems, drilling patterns and bean cultivars at Royal Agricultural University in 2015.

	Mix-proportion (%)	Chlorophyll content (CCI)	Light interception (%)	Grain CP concentration (g kg^{-1} DM)		Wholecrop Forage CP content (%DM)		Total wholecrop forage CP content (%DM)
		During active vegetative crop growth stages		Wheat	Beans	Bean	wheat	wheat + beans
Drilling patterns								
1 x 1	50:50	20.6^{a}	70.3^{a}	94.1	266.0^{b}	24.5^{a}	7.2^{a}	31.7^{bc}
2 x 2	50:50	20.7^{a}	74.5^{b}	96.6	279.2^{a}	25.8^{b}	7.5^{a}	33.3^{ab}
3 x 3	50:50	20.6^{a}	72.3^{c}	96.2	268.2^{b}	26.9^{c}	7.3^{a}	34.1^{a}
Broadcast	50:50	14.3^{b}	64.6^{d}	97.1	275.2^{a}	28.2^{d}	6.7^{b}	34.8^{a}
Bi-crop mean	50:50	19.1	69.4	96.0^{a}	272.2^{a}	26.3^{c}	7.2^{a}	33.5^{c}
Sole crop	100	6.7^{c}	58.8^{e}	86.1^{b}	271.5^{a}	27.4^{c}	5.7^{c}	34.1^{a}
SED(P≤0.05)		0.476***	1.775***	5.62***	5.82*	0.855**	0.586**	1.753*
Bean cultivars								
Fuego	50:50	19.1	72.1	95.9	261.5^{b}	25.9^{b}	7.3	32.8
Maris Bead	50:50	19.1	67.7	96.1	282.9^{a}	27.9^{a}	7.0	34.7
SED(P≤0.05)		0.435^{ns}	2.51***	5.92^{ns}	6.5***	0.956*	0.535^{ns}	4.624^{ns}

Drilling alternate rows bi-crop plots

1x1 drilling pattern

2x2 drilling patterns

Cropping systems:

- Bi-cropping outperformed sole wheat cropping on chlorophyll content (64.8%); light interception (15.0%); wheat grain CP (10.3%) and wholecrop wheat forage (20.8%).
- Bi-cropping did not negatively affect bean grain CP; bean wholecrop forage CP and total wholecrop CP.

Bean cultivars:

- Bean cultivars influenced CP more than drilling patterns.
- Maris Bead bean consistently outperformed Fuego bean cultivar on bean grain CP (8.2%) and wholecrop bean CP (7.7%).
- Bean cultivars had equal influence on chlorophyll content; wheat grain CP and wholecrop wheat CP.
- Fuego bean cultivar intercepted more light than Maris Bead bean by 6.1%.

Drilling patterns

- Alternate rows bi-cropping was superior over the broadcast form of bi-cropping on chlorophyll and light interception
- The 2x2 drilled bi-crops gave better performance, an indication of interspecies complementarity

Conclusion

- **The study reveals the feed potential of bean/wheat ecological intensification (CIRAD 2015) for wholecrops forage production.**
- Better utilization of light and chlorophyll in bi-crop mixture than sole wheat crop.
- The 2x2 alternate row drilling pattern gave better performance than broadcast and sole wheat**.**

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