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Investigating the Food Security of Legumes and the Economic Effects of its Supply Chain

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Abstract

Relay cropping of maize with finger millet (maize/finger millet) is the predominant cropping system for sustaining food security situation in the hilly regions of Nepal. In this region weed coverage severely reduced crop yields. There is any Basic information on weed species composition, biomass production and their effect on crop yields and economics. it is necessary to use these information to develop effective weed management strategies for the future. In light of this, an empirical study was carried out in two representatives mid-hill districts of Parbat and Baglung during the summer season of 2010/2011 in Nepal. ten major weed species in Baglung with densities of 172 in Parbat and 311 per 0.25m2 area were observed. The highest percentage of both relative and absolute densities were recorded for Ageratum conyzoides in Parbat and Polygonum Chinensis in Baglung. Weed invasion under farmer's practice of crop management reduced the maize grain yield by 1.985 Mt ha-1 (117%) in Baglung and 1.760 Mt ha-1 (108%) in Parbat. Similarly, in finger millet, it was 0.489 Mt ha-1 (63%) in Baglung and 0.403 Mt ha-1in Parbat. in addition, the combined yield of both crops was also significantly reduced by 79.3% and 61.7% in Baglung and

Parbat, respectively. Hence, weeds are directly affected the crop performance in this region. as results it could be recommended that, there is an urgent need to develop an alternative crop production system in the hills.

Keywords: Maize/finger-millet, hills, weeds, index, grain yield

Introduction

Maize (Zea mays L.) is the second and finger millet (Eleusine coracana Gaertin.) is the fourth cereal crops which are most widely produced in Nepal, and produced produced in the mid-hill regions over 70% of maize and 75% of finger millet . Of the total area under finger millet cultivation, 85% is relayed with maize in Nepal. Maize-millet systems are beneficial to farmers because of reduced land preparation and more efficient utilization of moisture, nutrient, and labor resources (1-4). Yet low productivity of maize-millet systems (average yields of 2.5 Mtha-1 for maize and 1.13 Mtha-1for finger-millet (5) is hindering food security in the mid-hills.

The current food system (production, transport, processing, packaging, storage, retail, consumption, loss and waste) feeds the great majority of world population and supports the livelihoods of over 1 billion people. Since 1961, food supply per capita has increased more than 30%, accompanied by greater use of nitrogen fertilisers (increase of about 800%) and water resources for irrigation (increase of more than 100%). However, an estimated 821 million people are currently undernourished, 151 million children under five are stunted, 613 million women and girls aged 15 to 49 suffer from iron deficiency, and 2 billion adults are overweight or obese. The food system is under pressure from non-climate stressors (e.g., population and income growth, demand for animal-sourced products), and from climate change. These climate and non-climate stresses are impacting the four pillars of food security (availability, access, utilisation, and stability) [6-8].

Observed climate change is already affecting food security through increasing temperatures, changing precipitation patterns, and greater frequency of some extreme events (high confidence). Studies that separate out climate change from other factors affecting crop yields have shown that yields of some crops (e.g., maize and wheat) in many lower-latitude regions have been affected negatively by observed climate changes, while in many higher-latitude regions, yields of some crops (e.g., maize, wheat, and sugar beets) have been affected positively over recent decades. Warming compounded by drying has caused large negative effects on yields in parts of the Mediterranean. Based on indigenous and local knowledge (ILK), climate change is affecting food security in drylands, particularly those in Africa, and high mountain regions of Asia and South America [9-12]. Weed infestation is one of the major factors which contribute to low system productivity in the hills. However, there is lack of information on the major weed species and their effects on yield for maize-millet systems. Therefore, the present investigation was carried out to identify the major weed species and determining what extent the weed infestation affect this system's yield in the mid-hills of Nepal [13-14].

Materials and Methods

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Study site

This study was carried out at Pang village in Parbat and Langgaun in Baglung district in the western hill region of Nepal. The prevailing cropping system of the region was maize/finger millet during the rainy season and wheat/ rapeseed-mustard in winter. Soils of both locations were reddish-brown in color, clay-loam in texture and had a pH of 6.0 to 6.5 in Lunggaun and 6.0 in Pang. Total soil NPK was 0.18% , 71ppm and 111mg kg-1 in Lunggaun, and 0.21%, 65 ppm and 95 mg kg-1 in Pang. Soil organic carbon at both locations was 1.6 percentage. The highest rainfall was recorded during July and June (1677 and 1558 mm, respectively). November and January received no rainfall. Averagly the maximum and minimum temperatures of the region were 22.39 and 12.11°C during the survey year.

Experimental setup

Maize seed was planted in both sites during the second week of April 2010. Finger millet was relay planted in standing maize 55 days after maize seeding. The crop was manured with ten tons of farmyard manure (fresh weight) per hectare during land preparation and 40 kilograms of urea (46% N) per hectare was applied as top dressing during the knee-high stage of the crop. All crops maintained under rainfed conditions

Two weed management treatments representing conventional farmers' practice (FP) of weed management and weed free (WF) were implemented in the field of ten farmers, 5 from each village. Farmers performed all other field operations according to their usual practice. The comparison between FP vs. WF was carried out on five farmer's fields in both Pang and Lunggaun. Every field contained four plots included FPP and RPP treatments running parallel in strips. Quadrats were in 5m x 5m (25 m2). In the FP plots, farmers performed three cultivations, the first at 30-40 days after seeding, the second at earthing up operation (inter-row cultivation) and the third at finger millet transplanting time. Cultivation operations were performed using a small locallyiron made hoe.thus Weed-free plots were also treated with three cultivations procedure as mentioned above, but, weeds were pulled out immediately after the emergence by hand on a regular interval by seven days basis.

Observations recorded

In order to record the dominant weed species and work-out their relative density, absolute density, relative frequency, and absolute frequency under maize-based systems, 4 quadrants of 0.5 X 0.5 m2 were placed in each farmer's field for all five plot. Weed species, densities, and biomass (dry weight) data were estimated from quadrats during the inter-row cultivation (earthing-up operation) at 75 days after seeding (DAS) of maize. The second observation was at crop physiological maturity stage. Weeds inside the quadrats were counted and classified and their biomass was recorded in grams per unit area. For this, the weeds inside each quadrat were harvested, recorded and then oven dried for 48 hours at 700C. Average weed dry weight was calculated and then converted into m-2. Various weed indexes were calculated as below:

Relative population density (RD) (%) = Absolute density for a given species X100
Total absolute density for all species

Absolute population density= Total no. of individuals of a species in all quadrates
Total number of quadrates

Relative frequency (RF) (%) = Absolute frequency value for a species X100
Total absolute frequency values for all species

Absolute frequency (%) = Number of quadrates in which species occurs x 100
Total number of quadrates

Table 1. Weeds and population in a 0.25 m2 area during the rainy season under maize-based cropping system in Pang, Parbat

Quadrat No	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	Total
1	7	2	3	4	0	2	13	0	0	0	31
2	13	9	4	3	2	1	9	0	2	0	43
3	7	8	5	4	0	2	12	0	1	0	39
4	7	3	2	2	0	2	9	0	0	0	25
5	9	2	3	2	0	0	11	0	7	0	34
Species total	43	24	17	15	2	7	54	0	10	0	172

Note: theweed spec'es are me ıtioned in table 3 **ng**
name of

Table 2. Wee s and po ulation in a 0.25 m2 area duri ıg rainy season unde r maize based cropp ng system in Lung ıun, Baglı

Quadrat No	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	Total
1	19	12	1	9	2	8	2	4	2	4	63
2	4	11	3	11	0	11	1	7	2	5	55
3	3	7	2	7	2	13	0	3	9	1	47
4	4	17	0	4	1	2	2	11	4	14	59
5	16	13	0	3	7	20	0	12	7	9	87
Species total	46	60	6	34	12	54	5	37	24	33	311

Note: name of weed species are mentioned in table 3

Table 3. Major weed species under maize-based cropping system

Weed species No	Nepali name	Scientific name
W1	Abhijalo	*Drymaria cordata*
W2	Ratnaulo	*Plolygonum chinensis*
W3	Kodejhar	*Dactyloctenium aegypticum*
W4	Banso	*Echinochloa colonum*
W5	Mothe	*Cyperus rotundus*
W6	Kanejhar	*Commelina spp*
W7	Gandhe	*Ageratum conyzoides*
W8	Chariamilo	*Oxalis spp*
W9	Dubo	*Cynodon dactylon*
W10	Siru	*Imperata cylindrica*

xxx-xxx

Analysis of variance for yield parameters of maize and finger millet was performed by GENSTATC discovery version. Treatments were compared by “F-test” and significant differences between treatments were compared with Least Significant Difference (LSD) at 5% level of probability.

Results and Discussion

Major weeds and densities

density variation among weed species was found to be significant in both Parbat and Baglung. Almost all weed species were common in both the sites except *Imperata cylindrica* and *Oxalis spp* were not observed in Baglung. Weed density of *Drymaria cordata* and *Cynodon dactylon* did not vary by the sites. However, higher densities were recorded in *Polygonum chinensis, Echonochloa colonum, Commelina spp* in Parbat inspite of Baglung. Whereas, only one species *Ageratum conyzoides* was recorded to be the highest in density in Baglung compared with Parbat (Table 1, 2 and 3). Similar weed species were also observed and reported in Lumle (1600 m.asl) in Kaski (Karki *et* 2010).

Weed indexes

In Parbat : The highest Relative Density (RD%) or Community Abundance (CA%) was observed in *Ageratum conyzoides* (W7) with 31.40 followed by 15 in *Drymaria cordata* (W1) and 13.95 in *Polygonum Chinensis* (W2) and 9.88 in *Dactyloctenium aegypticum* (W3) (Table 4).

Similarly, the Absolute Density (AD) was also observed as 10.8, 8.6, 4.8 and 3.4 in *Ageratum conyzoides* (W7), *Drymaria cordata* (W1), 13.95 in *Polygonum chinensis* (W2) and 9.88 in *Dactyloctenium aegypticum* (W3) respectively(Table 4).

Absolute frequency (AF%) (14.71) was recorded in *Drymaria cordata* (W1), *Polygonum chinensis* (W2) and *Dactyloctenium aegypticum* (W3) with the lowest value of 0 in *Ageratum conyzoides* (W7), *Cynodon dactylon* (W9) and *Imperata cylindrica* (W10) (Table 4).

In Baglung: The highest Relative Density (RD%) or Community Abundance (CA%) was found in *Polygonum chinensis* (W2) with 19.29 followed by *Commelina spp* (W6) with 17.36, *Oxalis spp* (W8) with 11.90, *Echinochloa colonum* (W4) with 10.93 and *Imperata cylindrica* (W10) with 10.61. The lowest value of 1.61 was recorded in *Ageratum conyzoides* (W7) (Table 4).

Absolute Density (AD) was the highest in *Polygonum chinensis* (W2) with 12.0 followed by *Echinochloa colonum* (W4) with 10.8, *Drymaria cordata* (W1) with 9.2 and *Oxalis spp* (W8) with 7.4 having the lowest of value 1 in *Ageratum conyzoides* (W7) (Table 4).

Absolute Frequency (AF%) value of 11.11 was recorded in *Drymaria cordata* (W1), *Polygonum chinensis* (W2), *Echinochloa colonum* (W4), *Commelina spp* (W6), *Oxalis spp* (W8), *Cynodon dactylon* (W9) and *Imperata cylindrica* (W10) (Table 4). However, the lowest value of AF (6.67 %) was recorded in *Ageratum conyzoides* (W7) and *Dactyloctenium aegypticum* (W3) (Table 4).

Effect of weed on maize and finger millet grain yield

Irrespective of location, higher grain yields were recorded for maize under weeds free treatments rather than in weed management treatments under farmer's routine practice. However, the fertility status of the field plots was not evaluated, hence the grain yield might be affected accordingly.

It is also interesting to note that in Baglung, although WF plots showed higher grain yield than FP plots, they also showed a higher level of variation. This might be due to variations in the composition of weed species, initial densities, or ground coverage of weeds. The findings were in accordance with the Knezevic *et al* (2002)results.

In Parbat, the variation in grain yields of both crops was observed to be narrow (Table 5). The reduction in grain yield caused by weeds may be attributed to several factors like weed-crop competition for moisture, nutrient, and light (Hussain *et al* 2008).

Table **4**. Relative and absolute densities, relative and absolute frequenc ies of major weed species across the survey districts

Particular	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	Total
Pang, Parbat											
RD(%)	25	14.0	9.9	8.7	1.2	4.1	31.4	0	5.8	0	100
AD	8.6	4.8	3.4	3	0.4	1.8	10.8	0	2	0	34
AF (%) 14.71	14.7	14.7	5.8	11.8	14.7	0	8.8	0	0	100	

Lunggaun, Baglung RD											
(%) 14.8 19.3		1.9	10.9	3.9	17.4	1.6	11.9	7.7	10.6	100	
AD	9.2	12	1.2	6.8	2.4	10.8	1	7.4	4.8	6.6	62.2
AF (%) 11.1	11.1	6.7	11.1	8.9	11.1	6.7	11.1	11.1	11.1	100	

Note: name of weed species are mentioned in table 3

xxx-xxx

Table 5. Grain yield of maize and finger millet as affected by weed management practices in Baglung and Parbat, 2010.

Location/practice	Grain yield (Mt ha^{-1})		
	Maize	Fingermillet	Combined
Baglung			
Farmers practice	1.683	0.776	2.601
Weed free	3.668	1.265	4.666
Yield gain (Mt ha^{-1})	1.985 (117)	0.489 (63)	2.064 (79.3)
Parbat			
Farmers practice	1.628	0.829	2.751
Weed free	3.388	1.231	4.450
Yield gain (Mt ha^{-1})	1.760 (108.1)	0.403 (48.6)	1.699 (61.7)
Grand mean	2.595	1.025	3.617
$LSD_{0.05}$	0.225	0.106	0.312
CV,%	8.6	10.2	8.5

Note: figures in the parentheses are the percentage increase in yield

Conclusion

overall 10 weed species were found in common in maize field for both districts during 2009. Among them, grasses were dominant. The highest value were recorded for Ageratum conyzoides in Parbat and Polygonum chinensis in Baglung.for the both relative and absolute densities The higher absolute frequency percentage was recorded in

Drymaria cordata, Polygonum chinensis and

Dactyloctenium aegypticum had the lowest value of 0 in Ageratum conyzoides, Cynodon dactylon, and Imperata cylindricain Parbat. as in Baglung, the absolute frequency was higher than in Drymaria cordata, Polygonum chinensis, Echinochloa colonum), Commelina spp, Oxalis spp, Cynodon dactylon and Imperata cylindrica with the lower value which was recorded in Ageratum conyzoides and Dactyloctenium aegypticum. maize grain yield under weed-free conditions was 2.5Mt ha-1 in Parbat and 2.7 Mt ha-1 in Baglung, whereas in weed management by farmer's practice it was 1.6 Mt ha-1 in Parbat and 1.7 Mt ha-1 in Baglung. Similarly, the grain yield of finger millet losses due to weed infestation was up to 47.2%, when the maize field kept un-weeded throughout the first growing season.

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