Demonstration/display and suitability assessment of Zinc fortified and high yielding wheat cultivars in Janaki Municipality

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Background

Wheat crop is the major contributor to feeding Nepalese population after rice. In terms of nutritional protein contributed by cereal, it ranks first globally. The demand for wheat and wheat based products is expected to increase substantially in upcoming years. Thus, it will have a huge role to play in achieving a state of food sufficiency and nutritional adequacy in Nepal.

Wheat is one among a few major food crops grown worldwide. It is often times credited for having had a central role to the beginning of agriculture (Harlan 1981). The Bread Wheat, having one of the largest known genome size among cultivated crops, is very versatile in its environmental adaptability, growth habit, phenology and physiology. Result of all these processes is a crop that produces different quantities of grain under different input management and is composed of variable nutritional attributes. Of all micronutrients that wheat caters to, Zinc is of special interest because of its unique role in human body as an element that promotes muscle growth, enables tissue and cells repair and in conjunction with vitamins, keeping them biologically active, helps us fight disease and infections. One of the major problems faced by progressive Nepalese families is Zinc deficiency anaemia and poor absorption of bodily vitamins.

Although choice of crop cultivar is a new practice, extensive research into phenotype and genetics of wheat has ever-long sustained increasing yield gains over time. More frequently, highest yielding so called "Super wheat" have robust semi-dwarf stems, broad leaves, large spikes with a greater number of grains per head, and higher grain weights (Swaminathan 2007). Recent works, in developing countries, have advocated for testing and selection of wheat cultivars in the same target environment wherein the crop will ultimately be cultivated. This is to address the farming community's need by understanding the production dynamics in agro-ecological context of the community by taking into account locale specific farmers' knowledge on performance attributes of the crop. Finally, as end users, farmers will positively receive the attributes that one or few cultivars possess in light of the test being conducted in the same or nearby environment hence increasing the cultivars' acceptance and adoption.

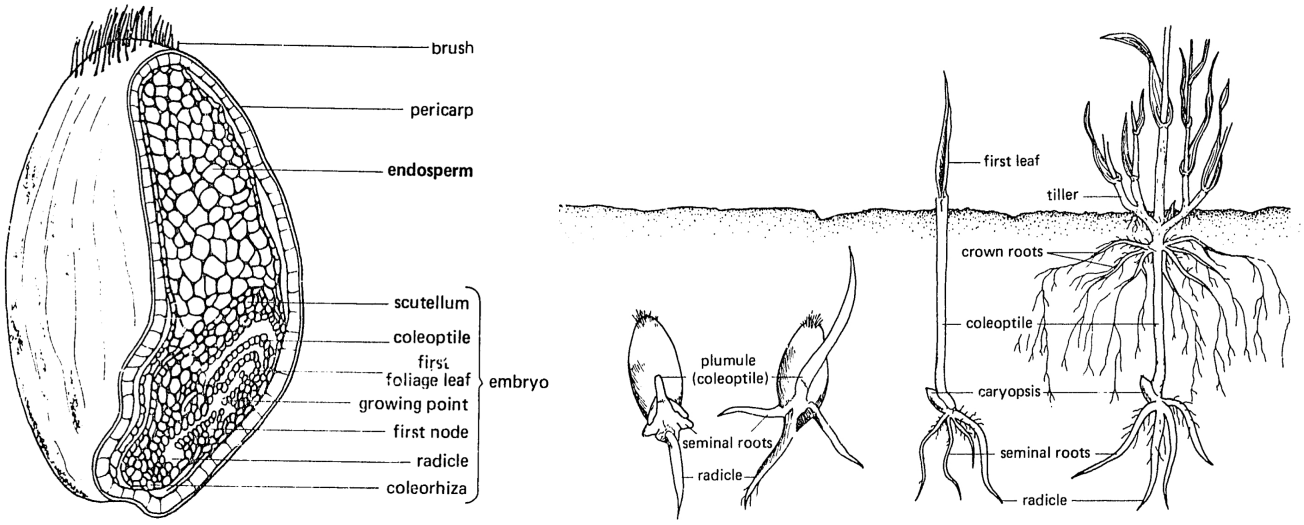
Wheat morphology and growth

The cereal seed or kernel (technically a caryopsis), consists of pericarp, the embryo and the endosperm. In the process of germination, the embryo resumes its growth when exposed to suitable environmental conditions. From the emergence of the young seedling at the soil surface to the production of the mature seed, the growth of the wheat plant can be divided into a number of (sometimes simultaneous) stages.

Table 1. Identifying features of Wheat growth stages.

Growth stage	Key features
Seedling growth	Leaves unfold, from the first one breaking through the coleoptile to the appearance of the flag leaf ligule.
Tillering	Additional (secondary) shoots arise from the plant crown.
Stem elongation	The first pseudostem is erected and the nodes become visible; upper leaf sheath is not swollen by the head.
Booting	Head is evident in the upper or flag leaf.
Ear emergence	Head emerges from the sheath.

Flowering	Florets and flowers open; pollen is shed.
Milk development	Fertilized ovary enlarges to mature seed size; its contents become increasingly white and opaque.
Dough development	Ovary contents solidify.
Ripening	Seed becomes hard; harvest.



(a) Wheat caryopsis (b) Morphology of germinating wheat and its seedling development

Figure 1. Wheat morphology.

Character expression of a crop depends upon its cultivar, which in-turn is the sum of its genetic components. These characters (such as plant height, growth habit, photoperiod response, yield potential and disease resistance) are controlled by units of inheritance – genes, which are located on the chromosomes of plant cells.

Objectives

- To observe and assess the yield of popular, released/registered and promising wheat cultivars.
- To identify wheat cultivar with good palatability/taste when eaten as bread.
- To identify wheat variety with high Zinc content.

Methodology

The observation/demonstration field will consist of 28-30 genotypes, most of which are zinc fortified advanced lines (or varieties) curated from either international (CIMMYT) and national (NWRP) breeding nurseries while select few are popular released/registered varieties in use.

Plots sown to different genotypes will be managed in accordance to established practice in the region. The field will be prepared for clean cultivation before sowing, manual weeding operations will follow to check weed proliferation. Randomly placed sampling frames from the experimental plots will form the unit of sampling and data aggregation before statistical interpretation. Phenotypic characteristics (including those related to morphology, phenology, stress/disease rating and yield) will be acquired periodically, while adhering to the general guideline of growth stages rating and identification keys as codified by (Zadoks et al. 1974) (Table 1).

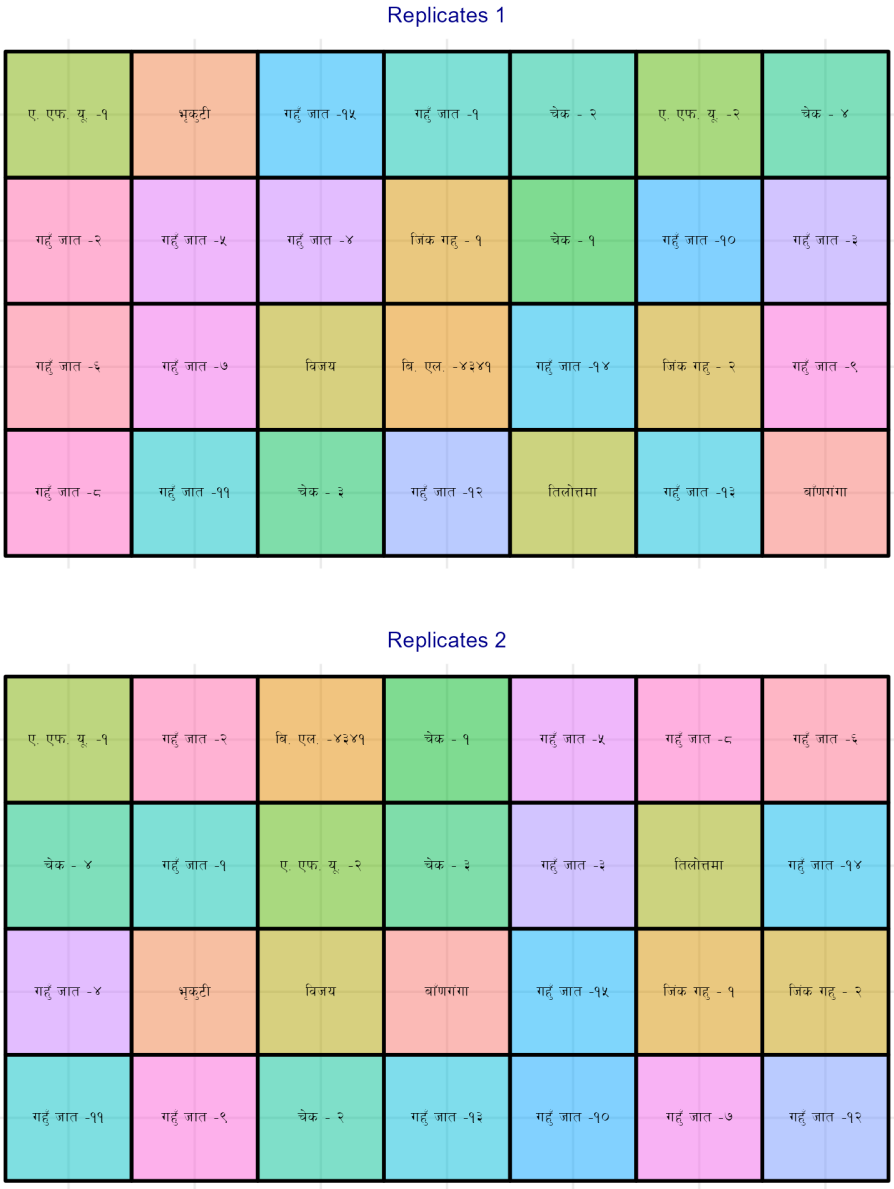


Figure 2. Field layout plan for Alpha-lattice design (Number of treatments = 28, Blocks = 8, Replicates = 2).

Management

The after the prepartion of field, wheat field is expected to be sown during mid Kartik (3rd or 4th week of November). Standard agronomic practices recommended for normal fertility maintainance will be followed. Full rates of K2O (50kg/ha) and P2O5 (50kg/ha) will applied at the time of sowing. Nitrogen will be applied in split doses– 50 kg N ha^{-1} as basal and remaining 50 kg N ha^{-1} top dressed after irrigation.

For entire field (2 kattha $\simeq 660m^2$), fertilizer will be allocated on net plot basis

- Basal
  - 5.77 kg Urea
  - 7.174 kg DAP
  - 5.5 kg MoP

- Top dressed
  - 5.77 kg Urea

Planting distance

Within rows in a plot, seed will be sown continuously. A row spacing of 25cm in between distance will be allowed. A depth of 3-5cm below the surface will be the expected below soil surface distance for seed placement.

Interculture operations The problem of weed is most severe in dry pockets of the field. As such, single weeding under normal conditions during tillering stage shall suffice to check growth of any weeds.

- Total area of field: $660m^2$
- Gross plot size (on field basis): 11.786 m^2
- Total number of blocks: 8 (4 in each replicate)
- Spacing between adjacent block: 0.5 m
- Spacing between plots within the block: 0.5 m (one row skipped)

Observation and data recording

The record of all observations made on field, those including crops' yield, morphology, phenology traits, and fields' soil and atmospheric conditions has been shown in Table 2.

Table 2. Field records of crop yield, morphology, phenology and quality related information and observation period.

Data	Stage recorded
Seedling emergence	When approximately 50% of all plots' seeds are visible
Days to booting	When approximately 50% of the plants in a plot are at Zadoks stage 45
Canopy sparseness	Heading (Zadoks stage 55)
Leaf glaucousness	Anthesis (Zadoks 60)
Weed score	Medium milk (Zadok stage 75)
Disease score	Anthesis and Late milk (Zadoks stage 65 to 77)
Days to anthesis	When approximately 50% of the plants in a plot are at Zadoks stage 65
Insect foliar damage score (if any)	Anthesis (Zadoks stage 65)
Leaf area	Medium milk (Zadok stage 75)
Plant height	Medium milk (Zadok stage 75)
Number of effective tillers	Medium milk (Zadok stage 75)
Flag leaf greenness rating I	Medium milk (Zadok stage 75)
Flag leaf greenness rating II	Soft dough (Zadoks stage 85)
Defective heads count	Ripening (Zadoks stage 90)
Leaf senescence/chlorosis	Ripening (Zadoks stage 90)
Panicle length	Ripening (Zadoks stage 92)
Days to maturity	Ripening (Zadoks stage 92)
Number of grains per panicle	After harvested
Thousand kernel weight	After harvested and dried
Grain yield	After harvested and dried
Palatability/taste rating	After harvested and dried
Zinc content	After harvested and dried

Yield and rating/scoring observations will be recorded on plot basis after maturation, while features like plant height, plant per unit area, number of tillers per plant, number of grains per plant, test weight, etc. will be observed on sample (either plant or area basis) according to established set of practice for ontological characterization.

Timeline

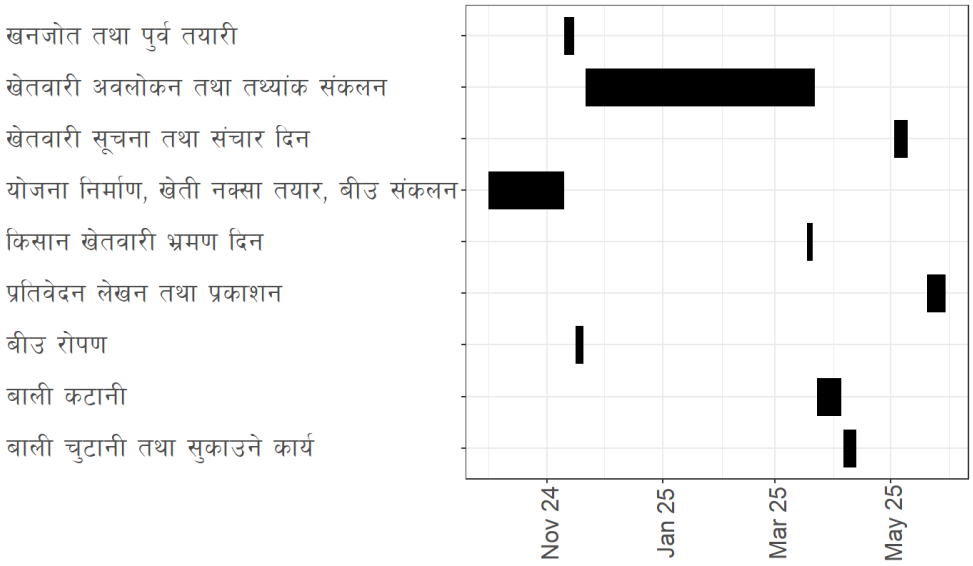


Figure 3. Timeline of plan of activities for field demonstration and field day organization.

Projected outcome

- Broad range of options will be available for farmers to choose from for cultivation of wheat in Janaki Rural Municipality.
- Farming community will have opportunity to constantly monitor and assess performance trait of prospective wheat varieties, hence may find one or few germplasm preferable for existing varieties.
- On farm testing of the wheat cultivars will lead to realistic assessment of yield and quality performance of wheat genotypes.
- Farming household will have a chance to adopt a cultivar that is more nutritious with respect to Zinc content, thereby community might reduce (if prevalent in hidden or symptomatic form) of zinc-deficiency anemia.
- Based on overall performance of genotypes, recommendation for advancement into further generation will be made.
- Best performing wheat cultivars with their traits of preference can be identified.
- Provides an assessment of how well the released/notified national wheat cultivars are to the farming agro-ecology of Janaki Rural Municipality.
- Field day programme will sensitize farming households on the importance of mineral nutrition to human health and well being.
- Field day assessment of organoleptic palatability/taste of wheat cultivars will enable farmers to have a choice of wheat cultivar based on their taste as bread, hence possibly resulting in an increased consumption of wheat in daily diet.

Beneficiaries

- Farming community engaged in wheat production
- Natural sciences researchers and students, mainly of agriculture, ecology and environmental sciences field.
- Local (municipality), regional and central level governing bodies, alongside NGOs and INGOs working on agriculture planning and practicing natural resource management.

Budgeting

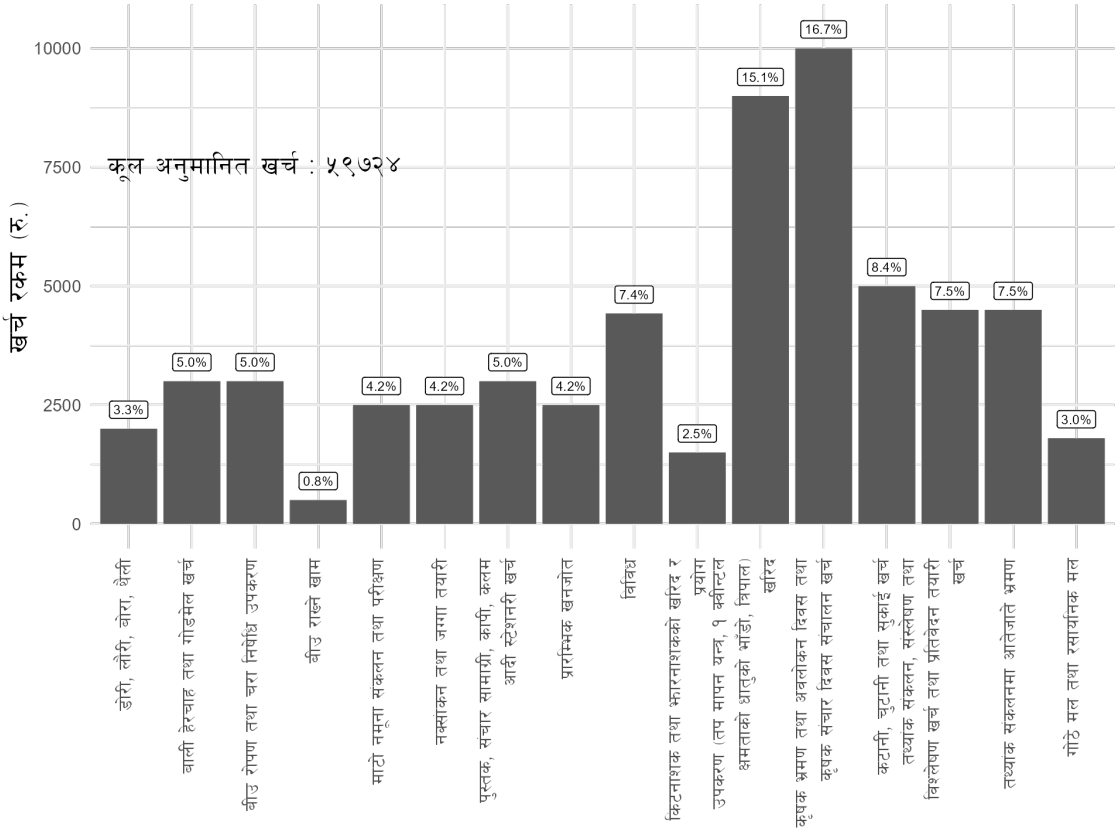


Figure 4. Budget estimates for demonstration of high yielding and zinc enriched Wheat cultivars.

References

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