2018 MTGF Research Gift Proposal

Project Title:

Pre-Game Agronomic Field Safety Assessment for Sports Fields: Future Implications of Risk Assessment

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Abstract:
One of the most difficult turfgrass areas to manage is sports fields due to the intense traffic (wear and compaction) they receive by players on a regular basis. Due to high expectations regarding player safety by players and coaches, field safety and maintenance checklists need to be developed specifically for sports turf fields. Currently, checklists consist mainly of facility-based questions and only address turfgrass uniformity for bare spots. Therefore, the purpose of this study is two-fold: (1) develop a pre-game sports field assessment that measures agronomic fundamentals related to soil and plant health, (2) determine the impact field improvements identified by the pre-game assessment have on player injury. This data will help sports field managers ensure player safety on turfgrass sports fields in the future.

Rationale for Research:
Legal liability has become a serious concern for sports turf mangers in recent years. Sports played on turfgrass athletic fields can easily result in injury to players, and there have been many cases where these injuries could be blamed on field conditions. Current field safety and maintenance checklists are generic, predominantly focusing on goals/goal posts, field markings, out of bound or transition areas, fencing, bleachers, facilities, lighting, bases and anchoring. When the playing surface is addressed, the evaluator is looking for the presence or absence of bare spots, weeds, holes, and ruts. With the use of technology, more agronomically-based measures can be obtained to determine the playability of a sports field measuring soil compaction, soil moisture, surface firmness and overall turfgrass health and quality. If the assessment is conducted soon enough, sports managers can implement improvements to the field prior to the next game to reduce player injury.

Potential Benefits of Research:
This assessment would answer pre-game questions related to the suitability of the turf for sports activity to prevent player injury. Agronomic problems or issues with the playing surface would be identified through the assessment with the grounds staff using the information to implement cultural practices intended to improve field conditions. These cultural practices would improve the general aesthetics of the field prior to the next home game. This assessment could be added to existing field safety checklists utilized to improve the overall agronomic and turf quality of any sports field.

Project Background:
One aspect of athletic facility management essential to facility managers is to manage any potential risks associated with game attendance. They owe a duty of care to all in attendance, employees, and the athletic participants. An early assessment of risk conducted in the United Kingdom on football pitches consisted of calculating a Ground Player-safety Score (GPS) primarily involving assessing field dimensions to ensure players venturing out of the field of play did not encounter obstacles and structures that could cause injury. While this assessment was beneficial in determining safe field dimensions, it did not account for actual conditions of the pitch. Future endeavors in assessing field conditions have been conducted, but more is needed in addressing the agronomic principles involved in maintaining athletic fields.

Athletic turf is intended to support a broad array of athletic activities in which player safety and spectator aesthetics are important considerations. Sports fields are designed to meet two basic

requirements: (1) they must be large enough or the necessary shape to allow the particular sport to be played according to its recognized rules and regulations and (2) they must have a surface that allows the players to compete safely and at a reasonable level of competition. Player performance and safety depends on the quality of the turfgrass stand. Turfgrass quality is a function of its utility, appearance, and playability; thus, it is related to the type of, and intended use for, the turf.

In sports turf, turfgrass quality is simply dependent on three characteristics: traction, hardness, and evenness. Traction is critical to generating and controlling player speed, making sharp turns, and stopping. In addition to reducing a player's ability to avoid or to control collisions, poor traction can lead to muscle pulls and a variety of other injuries. Hardness allows a player to perform at maximum speed, but can also affect player's ability to cut sharply and increase injury from falls and tackles. Evenness, along with hardness, is a major factor affecting ball response, which includes height and direction of ball bounce, as well as the trueness and speed of roll. In a previous study conducted at Penn State University, researchers found that 21 percent of the recorded injuries in football games and practices were either definitely or possibly related to the playing surface. A follow-up study showed that athletic-field managers could influence playing-surface quality or traction through management practices that affect soil-water content, soil density and turf cover. Playing-surface hardness can affect both player performance and player safety and refers to the ability of the surface to absorb impact energy created by a player. Soil compaction occurs when mineral particles have been pressed close together from excessive and concentrated traffic. Root function decreases under compaction due to the lack of oxygen needed for respiration and due to buildup of toxic gases such as carbon dioxide, methane, or sulfides. Compacted soils surfaces also reduces water infiltration and percolation rates. Cultivation practices include a variety of mechanical processes that are used to loosen the soil and reduce compaction, to reduce thatch, or to groom the surface to reduce hardness. Evenness of the playing surface is influenced by turfgrass density, cover, and uniformity. Current checklists determine evenness by visually assessing for bare spots, weeds, holes or mounds, and ruts or trenches. Percent turfgrass cover on the field is also assessed visually, with a minimum goal of 75% coverage. Turfgrass uniformity is determined by color, height, and overall density of the turfgrass stand. In general, most field safety checklists are facility based focusing on goals/goal posts, field markings, out of bound or transition areas, fencing, bleachers, facilities, lighting, bases and anchoring. The playing surface component of these checklists need to include analytical measurements of surface traction, hardness, and evenness.

It is our goal to develop an agronomic assessment that can be added to current safety checklists for sports turf that reduces player injury while increasing field playability. A majority of the agronomic assessments will be analytically determined by using a variety of gauges or hand-held meters that most turf managers use on a daily basis.

Objectives:

(1) Develop a pre-game sports field assessment that measures agronomic factors such as soil compaction in addition to turfgrass quality/uniformity to determine field playability.
(2) Determine the impact field improvements identified by the pre-game assessment have on the incidence of player injury.

Materials and Methods:
This research project will occur on UMC football field (game field) and soccer field (game & practice field). The field assessment will be conducted before each home game. Recommendations based on the assessment will be given to the Grounds staff for implementation. In addition, the Turf 3072 Turf Science and Turf 3076 Turf Management Systems class will help in implementing improvements to the fields prior to the next home game.

The agronomic assessment to ascertain field conditions will be developed using modern technology such as hand meters to determine the following soil conditions and overall plant health: soil compaction, soil moisture, surface firmness, and canopy greenness. Soil compaction will be determined using a FieldScout SC 900 soil compaction meter (Spectrum Technologies). Volumetric water content will be determined using a FieldScout TDR 300 (Spectrum Technologies). A FieldScout TruFirm (Spectrum Technologies) will be used to determine the firmness of the playing surface to compare surface consistency and variability. Canopy greenness will be determined using a NDVI FieldScout CM 1000 Chlorophyll meter (Spectrum Technologies). In addition, turf coverage, turf uniformity, rooting depth, and overall turfgrass quality will be assessed visually.

Athletic facilities have a duty of care owed to participants and spectators alike. A specific duty this study will address is player safety. A measureable way of assessing player safety is through identifying player injuries. There is a variety of methods of assessing injuries: prevalence, incidence, and incidence proportion (i.e., risk). Prevalence refers to the proportion of an athletic team who is injured at a given time. Incidence refers to new injury occurrences during a specified period of team (usually one season). Incidence proportion, or risk, refers to the proportion of athletes who have at least one injury during a fixed period of time (usually one season). All three methods will be utilized within this study to determine overall injury rates. Considering this study is focusing on injuries possibly related to field conditions, injuries will be categorized by type so as to identify which injuries come from field conditions and which injuries come from other means (such as helmet-to-helmet hits). Working with the athletic trainers, data related to injury prevalence, incidence, and risk will be associated with the agronomic indicators for healthy turf over the course of the season.

Anticipated Outcomes/Results:
Implementing cultural practices identified by the agronomic assessment, player safety will increase and player injuries related to field conditions will decrease. The overall playability and aesthetics of the field will improve greatly and players, coaches, and spectators will be satisfied to have a safe, uniform playing surface. These agronomic factors will be used to augment and replace items on currently used field safety and maintenance checklists making it generalizable to any athletic field.

<u>Pilot Study Results:</u>
Recommendations-

- Aerate field every two weeks to reduce compaction on the football field.
- Decrease irrigation based on soil moisture content readings and precipitation.
- Run uniformity test on irrigation system

Table 1. Soil Compaction and Soil Moisture readings for the UMC football field before each home game in 2016.

Field Assessment	**Game 1**	**Game 2**	**Game 3**	**Game 4**	**Game 5***	**Game 6**
Soil Compaction	50%	87%	70%	80%	10%	53%
Soil Moisture***	86%	ND	70%	20%	100%	90%

ND=No Data

Soil Compaction-% of measuring points having a cone index of >300 psi in top 4 inches (<30%-little to no compaction, 30-50%-slight compaction, 50-75%-moderate compaction, and >75%-severe compaction).

*Grounds aerified field before game 5.

Soil Moisture-% of measuring points having a % Volumetric Water Content of > 40% (Saturated silty clay loam soil).

Year 1 Results:

Table 2. Soil Compaction, Soil Moisture, Surface Firmness, and Turfgrass Color for both the UMC Football and Soccer field before each home game in 2017.

Field Assessment	**Game 1**	**Game 2**	**Game 3**	**Game 4**	**Game 5**
	Football Field				
Soil Compaction	77%	0%	0%	90%	0%
Soil Moisture	77%	100%	100%	100%	100%
Surface Firmness	ND	0.6-0.8	0.5-0.7	0.3-0.4 (100% Firm)	0.5-0.6
Turfgrass Color	.90	.90	.92	.90	.85
	Soccer Field				
Soil Compaction	4%	0%	0%	0%	0%
Soil Moisture	96%	100%	100%	100%	100%
Surface Firmness	0.6-0.7	0.6-0.7	0.5-0.6 (30% Firm)	0.5-0.6	0.4-0.5 (75% Firm)
Turfgrass Color	.91	.90	.92	.90	.85

ND=No Data

Soil Compaction-% of measuring points having a cone index of >300 psi in top 4 inches (<30%-little to no compaction, 30-50%-slight compaction, 50-75%-moderate compaction, and >75%-severe compaction).

Soil Moisture-% of measuring points having a % Volumetric Water Content of > 40% (Saturated silty clay loam soil).

Surface Firmness-the lower the penetration value, the firmer the turf (<0.49 inches).

Turfgrass Color- the Normalized Difference Vegetation Index (NDVI) measurements can range from -1 to 1, with higher values indicating greater plant health.

Table 3: Number of athlete injuries collected before each home game for football and soccer in 2017.

Injury Type	Game 1	Game 2	Game 3	Game 4	Game 5
	Football Field				
Concussion		1			1
Broken Wrist				1	
Knee					1
Shoulder				1	
Lateral Ankle Sprain	2	1			
Muscle Strains				2	
	Soccer Field				
Concussion	1				
Shin Splints	1				2
Stress Fracture	1				
Ankle Sprain				1	

Recommendations-

- Use soil compaction and surface firmness date to determine timing of aerification.
- Soil moisture needs to be addressed by maintenance staff. Fields were saturated for all games which can cause the turf to be extremely slick.

Collection of Year 2 data will begin in August 2018.

Deliverables:
Annual written reports on the progress of the project, a final report including all the data and analysis, one or more papers submitted on the international and national level to peer-reviewed scientific journals (Crop Science, Crop, Forage & Turfgrass Management, Journal of Applied Sport Management, or Journal of Sport Management), and multiple presentations at state, regional, and national conferences.

Data from year 1 was presented in both oral and poster format at the European Association for Sport Management Conference in Bern Switzerland (September 2017). I will also be presenting this research at the NCTGA Conference this week in Fargo, ND. We currently have two students, Ben Koisti and Jason Angelo, working on this project who received Crookston Student Research/Creative Works funding (similar to UROP).

Projected Budget (Year 2 for a 2-year field study):

I.	Undergraduate Student Salary	$3,000
II.	Field Equipment	$1,500
III.	Supplies	$500
	TOTAL	**$5,000**