Precision agriculture (PA) is a management strategy for addressing geographical and temporal variabilities in agricultural fields Alferd et al 2021, McFadden et al 2023, Monteiro et al 2021 that involves data and contemporary technologies. With a forecasted human population of between 9 and 10 billion by 2050 Monteiro et al 2021, Bhat, and Huang 2021, Yazdinejad et al 2021, precision agriculture is becoming more and more important to contemporary agricultural research. By 2050, the amount of food produced worldwide must grow by at least 70% Alferd et al 2021, Yazdinejad et al 2021, Cravero, and Sepúlveda 2021, Filipe et al 2019. This is a challenging endeavor Bhat, and Huang 2021 because it puts further strain on already-scarce resources and the environment Alferd et al 2021, McFadden et al 2023, Monteiro et al 2021. Therefore, precision agriculture is essential to maximize output while using fewer inputs of all sorts in more effective ways, reducing adverse impacts on the environment, and assuring sustainability McFadden et al 2023, Monteiro et al 2021. Integrating precision agriculture into tillage practices can revolutionize farming operations. Precision agriculture employs advanced technologies such as GPS, sensors, and data analytics to manage, track, and enhance crop or livestock production inputs Karunathilake et al 2023. This approach allows farmers to deliver exactly what a plant needs, when and where it needs it, and in the exact amount. In the context of tillage, precision agriculture can lead to more targeted and efficient soil preparation, reducing fuel consumption, labor costs, and environmental impact. By tailoring tillage to the specific needs of each part of a field, precision agriculture can significantly increase the efficiency of chemical and fertilizer use, avoid excess application, and ultimately contribute to more sustainable and productive farming. Precision tillage, in contrast to conventional methods, enables focused soil management, reducing the negative impacts of compaction on root growth and nutrient uptake. The emergence of precision agriculture has introduced innovative solutions such as precision tillage, which utilizes connectivity and data to enhance production. This method does not apply tillage uniformly across the field but instead implements it selectively based on the specific needs of different soil zones. This focused approach can potentially lessen the soil compaction layer, thereby fostering healthier root growth and improving the plant’s ability to absorb minerals from the soil. As evidenced by Olubanjo and Yessoufou (2019), high soil compaction adversely affects the plant’s ability to absorb minerals from the soil, thus reducing yield performance. By incorporating precision agriculture into tillage operations, we can tackle these challenges, laying the groundwork for sustainable and efficient agricultural practices. The study of soil compactness and its effects on agricultural productivity has been a subject of interest for many researchers. El-Wardany et al. (1996) demonstrated the effectiveness of vibration-based monitoring methods for detecting drill wear and breakage, highlighting the potential of such techniques in predicting soil compactness. Similarly, Andrade-Sanchez et al. (2008) developed a field-ready soil compaction profile sensor, which showed promising results in detecting differences in soil compaction. In the domain of precision agriculture, ArdEstAni (2013) utilized microgravity data to detect low-density zones in the foundation condition of a dam site, emphasizing the importance of compactness in soil mechanics. Batey & McKenzie (2006) and Batey (2009) discussed techniques for identifying soil compaction directly in the field, emphasizing the importance of assessing both primary and secondary effects of compaction. Cui et al. (2015) introduced the use of Ground Penetrating Radar (GPR) technology and ARMA power spectrum estimation for analyzing soil properties, aiming to establish models for evaluating soil properties in land consolidation engineering projects. Cutini et al. (2016) developed a simplified method for evaluating whole body vibration exposure of agricultural tractor operators, highlighting the role of tractor forward speed and terrain roughness in inducing vertical accelerations. de Lima et al. (2017) explored the impact of agricultural field traffic on soil compaction indicators, highlighting differences in compaction between soils with varying clay contents. Gebraeel et al. (2004) developed neural network models for predicting bearing failures based on vibration analysis data from accelerated fatigue testing on rolling contact thrust bearings, aiming to estimate failure times in real-time. Goyal & Pabla (2016) discussed the importance of vibration analysis in manufacturing processes and structural health monitoring, emphasizing the role of non-contact laser-based instruments for vibration measurement. Hemmat & Adamchuk (2008) reviewed sensor systems for measuring soil compaction, highlighting the need for direct field assessment and management strategies to mitigate its adverse impacts. Hemmat et al. (2014) developed a multiple-tip horizontal penetrometer for on-the-go soil mechanical resistance measurement and soil failure mode detection using acoustic signals. Hosseinpour-Zarnaq et al. (2022) developed a vehicle-mounted online system for measuring soil electrical conductivity and moisture content, demonstrating improved predictive accuracy with the binary model. Khandelwal & Singh (2009) demonstrated the successful application of artificial neural networks to predict blast-induced ground vibration and frequency, showing superior accuracy compared to conventional predictors and multivariate regression analysis. Magalhães & Cerri (2007) developed a yield monitor designed for precision agriculture in sugar cane crops, showing potential for use in this context. Meng et al. (2023) developed and tested a vehicle-mounted soil bulk density detection system. Monjezi et al. (2013) discussed the importance of predicting and controlling blast-induced ground vibration, comparing the accuracy of an artificial neural network (ANN) model with various empirical models in predicting peak particle velocity (PPV). Naderi-Boldaji & Keller (2016) explored the relationship between soil physical quality index S and soil compactness, highlighting the strong correlation between degree of compactness (DC) and ln (1/S). Nawaz et al. (2013) discussed the impact of soil compaction on agricultural productivity, food security, soil structure, and biodiversity, emphasizing the importance of understanding soil compaction processes. Nocita et al. (2015) discussed the potential of soil spectroscopy as an alternative to wet chemistry for soil monitoring. Ruiz-Gonzalez et al. (2014) developed an SVM-based classifier for estimating the state of various rotating components in agro-industrial machinery with a vibration signal acquired from a single point on the machine chassis. Sinfield et al. (2010) evaluated sensing technologies for on-the-go detection of macro-nutrients in cultivated soils. Taniwaki & Sakurai (2010) evaluated the internal quality of agricultural products using acoustic vibration techniques. Tashakkori et al. (2021) developed Beemon, an IoT-based beehive monitoring system that captures high-quality audio and video recordings, along with temperature, humidity, and weight data for analysis. Vomocil (1957) reviewed methods for measuring soil bulk density and penetrability, which are important indicators of soil compaction. Wang et al. (2023) developed a vehicle-mounted online system for measuring soil electrical conductivity and moisture content. Wu et al. (2020) introduced an EMI-based compactness measuring sheet for monitoring soil compaction. Yang et al. (2018) presented an exploratory study using piezoceramic-based active sensing and wavelet packet analysis for real-time monitoring of soil compaction. Zhang & Chen (2008) developed a tool condition monitoring system based on vibration data collected through a microcontroller-based data acquisition system. Zhang et al. (2016) developed a PZT-Based soil compactness measuring sheet using electromechanical impedance. Zhao et al. (2022) presented a real-time measurement method of soil compactness based on a fertilizing shovel, with a mathematical model established to characterize soil compactness by detecting the deformation of the fertilizing shovel arm. Aitkenhead & Coull (2020) presented a method to estimate soil profile depth, bulk density, and carbon concentration in Scotland, aiming to provide effective carbon stock mapping for the country. Precision agriculture so far mainly consists of variable rate technologies (VRTs), electronic maps, yield monitors, and guidance farming systems McFadden et al (2023), Liu et al (2021). Variable rate applications were firstly demonstrated in northern Germany and Denmark in 1988 after global positioning systems (GPSs) were available for civil services Haneklaus et al (2016). GPS services were opened for general use in U.S. farms in 1983 McFadden et al (2023). In the next decade, GPS technology facilitated farmers to precisely locate and map their fields Shin et al (2022), Hedley (2015), empowering them to manage their farmlands according to site-specific conditions and field variabilities. At the beginning of the second millennium, yield monitors were developed, enabling farmers to monitor crop yield in real-time via best matching Hundal et al (2023). In this research, we harness the power of the Agricultural Vibration Data Acquisition Platform (avDAQ) and machine learning to collect and analyze data from agricultural machinery. The avDAQ system, linked to a GPS sensor, adds precise spatial information to the collected vibration data, enabling a comprehensive understanding of vibration locations. Our goal is to maximize the potential of avDAQ to extract detailed insights about field soil conditions, geographical classification based on GPS, vibration, and penetrometer data using advanced machine learning models like Random Forest, XGBoost, Support Vector Machine (SVM). This method enhances our understanding of the complex interactions between tillage machines and field soil conditions, marking a significant advancement in precision agriculture. Our study incorporates the avDAQ