

SISTEM REKOMENDASI PUPUK NPK BERBASIS WEB MENGUNAKAN METODE K-MEANS

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ABSTRAK

Pertanian presisi menjadi salah satu pendekatan penting untuk meningkatkan produktivitas dan efisiensi penggunaan pupuk, khususnya pupuk NPK yang terdiri dari Nitrogen (N), Fosfor (P), dan Kalium (K). Penelitian ini mengusulkan pembangunan sistem rekomendasi pupuk berbasis web yang mampu memberikan dosis pupuk sesuai kondisi tanah melalui analisis kandungan N, P, dan K. Metode K-Means Clustering digunakan untuk mengelompokkan data kesuburan tanah ke dalam kategori rendah, sedang, dan tinggi, yang kemudian dipetakan menjadi rekomendasi dosis pupuk Urea, SP-36, dan KCl. Data input diperoleh dari kombinasi masukan manual dan sensor tanah, disimpan dalam basis data Firebase, lalu diproses pada backend menggunakan Python, dengan hasil rekomendasi ditampilkan melalui antarmuka web yang sederhana dan ramah pengguna. Hasil pengujian metode K-Means dilakukan pada delapan lahan sawah di dua kecamatan di Kabupaten Nganjuk, yaitu Kecamatan Gondang dan Kecamatan Sawahan yang meliputi lahan jagung dan padi. Hasil menunjukkan bahwa lahan di Kecamatan Gondang memiliki kandungan unsur hara Fosfor (P) sebesar 6,69–19,80 mg/100g dan Kalium (K) sebesar 15,03–45,42 mg/100g, lebih tinggi dibandingkan Kecamatan Sawahan yang memiliki kandungan Fosfor (P) sebesar 0,71–5,79 mg/100g dan Kalium (K) sebesar 1,14–13,04 mg/100g. Perbedaan kandungan unsur hara tersebut menghasilkan rekomendasi dosis pupuk yang berbeda dan lebih spesifik sesuai kondisi lahan. Selanjutnya, pengujian integrasi metode K-Means dan Fuzzy Sugeno dilakukan pada beberapa lahan sawah di Kabupaten Bangkalan menggunakan 16 data tanah sebagai data pelatihan. Hasil clustering menghasilkan tiga kategori kesuburan tanah yaitu rendah, sedang, dan tinggi yang digunakan sebagai dasar pembentukan fungsi keanggotaan fuzzy. Pengujian menunjukkan bahwa seluruh lahan berada pada kategori kandungan NPK rendah dengan rata-rata Nitrogen 0,4–0,6 ton, Phospate 19,10–27,03 mg/100g, dan Kalium 43,83–62,15 mg/100g. Melalui proses inferensi Fuzzy Sugeno, sistem menghasilkan rekomendasi dosis pupuk UREA sebesar 200 kg/ha, SP-36 sebesar 75–100 kg/ha, dan KCl sebesar 50 kg/ha yang kemudian disesuaikan dengan luas lahan.

Kata kunci: K-Means, Firebase, pupuk NPK, web

WEB-BASED NPK FERTILIZER RECOMMENDATION SYSTEM USING K-MEANS METHOD

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ABSTRACT

Precision agriculture has become an important approach to improving productivity and efficiency in fertilizer use, particularly NPK fertilizers consisting of Nitrogen (N), Phosphorus (P), and Potassium (K). This study proposes the development of a web-based fertilizer recommendation system capable of providing fertilizer dosage recommendations according to soil conditions through the analysis of N, P, and K nutrient contents. The K-Means Clustering method is employed to classify soil fertility data into three categories: low, medium, and high, which are then mapped into recommendations for Urea, SP-36, and KCl fertilizer dosages. Input data are obtained from a combination of manual entries and soil sensors, stored in a Firebase database, and processed on the backend using Python. The recommendation results are then displayed through a simple and user-friendly web interface. The K-Means method was tested on eight rice field plots located in two districts of Nganjuk Regency, namely Gondang and Sawahan Districts, covering both corn and rice cultivation areas. The results showed that land in Gondang District had higher Phosphorus (P) content, ranging from 6.69–19.80 mg/100g, and Potassium (K) content, ranging from 15.03–45.42 mg/100g, compared to Sawahan District, which had Phosphorus (P) levels of 0.71–5.79 mg/100g and Potassium (K) levels of 1.14–13.04 mg/100g. These differences in nutrient content resulted in distinct and more specific fertilizer dosage recommendations tailored to the conditions of each field. Furthermore, the integration of K-Means and Fuzzy Sugeno methods was tested on several rice fields in Bangkalan Regency using 16 soil samples as training data. The clustering process produced three soil fertility categories—low, medium, and high—which served as the basis for constructing fuzzy membership functions. The results indicated that all tested fields were classified within the low NPK nutrient category, with average Nitrogen values ranging from 0.4–0.6 tons, Phosphate values ranging from 19.10–27.03 mg/100g, and Potassium values ranging from 43.83–62.15 mg/100g. Through the Fuzzy Sugeno inference process, the system generated fertilizer recommendations of 200 kg/ha for Urea, 75–100 kg/ha for SP-36, and 50 kg/ha for KCl, which were then adjusted according to the field area.

Keywords: K-Means, Firebase, NPK Fertilizer, Web-Based System