

IOWA STATE UNIVERSITY

COLLEGE OF AGRICULTURE

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Subject: **Environmental Protection Commission — Alternative Considerations
Regarding Liquid Swine Manure Application Rates to Soybean**

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Introduction/Summary

Reasonable alternatives exist to the proposal under consideration by the Environmental Protection Commission that would eliminate the option to apply liquid swine manure to soybean. The alternatives, outlined in this document, provide for a lower application rate than the one currently allowed by the Iowa Department of Natural Resources (IDNR). This approach would give producers:

- flexibility in developing manure plans;
- the opportunity to make desired applications to soybean; and
- nutrient and production benefits from that application.

Current data from water quality research provide only a partial picture on expected nitrate losses with reduced application rates or application to continuous corn. With these uncertainties in mind, it would be reasonable to consider alternatives that would continue to allow the practice of manure application to soybean at a lower allowable rate while research and development of extension information continues.

Background and Key Concepts

Swine manure is an important crop nutrient resource. Crops that need fertilization respond positively to manure nutrient applications. Iowa producers have successfully used swine manure for that purpose for many years. Swine manure contains multiple nutrients, so its use typically is targeted to corn in order to gain economic utilization of the nitrogen (N) component.

Application is much less frequent to soybean, but it does occur and manure plans sometimes include application for soybean production. When manure is applied to soybean, the purpose usually is for reasons other than as an N source. Since soybean is a legume and can fix needed N not supplied from the soil, N fertilization is not a recommended practice. Reasons for applying manure to soybean include:

- supplying phosphorus (P), potassium (K) and other nutrients;
- providing greater crop residue cover and lower erosion potential when injected or incorporated into cornstalks instead of soybean stubble on erosive land;

- ensuring fewer crop production concerns due to non-uniform manure (N) application and uncertainty in N availability;
- providing flexibility in application plans; and
- achieving potential yield improvements.

Research in Iowa and Minnesota has documented increases in soybean yields with application of liquid swine manure, when a response to nutrients would not be expected. The reasons, although not clearly understood, could include a response to manure N, the ammonium form of N, slow release from organic N compounds or other growth factors. To date, the research has not provided an indication or prediction of when yield improvement will occur. Also, while yield improvements can be substantial, generally they are not large enough to pay for the lost opportunity cost of the N component. However, if a producer does not place a full fertilizer value on the manure N or does not have other crops that could benefit from the N application, then that lost opportunity would not be considered a detriment for manure application to soybean.

From a crop production viewpoint, applying swine manure to soybean is a beneficial practice with few negative consequences. In trials conducted in Minnesota, white mold disease and increased lodging occurred at some sites due to a larger soybean canopy resulting from swine manure application, but these results have not been noted in Iowa research.

From the viewpoint of maintaining soil fertility, it is clear that swine manure supplies N, P, K and other nutrients removed when crops are harvested. Documentation of benefit to the soil is clear for nutrients like P and K, but as explained above, is much less clear for N. As a legume, soybean symbiotically fixes N, but also takes N from the soil. Thus, soybean production results in a net removal of N from soil. The net removal has been estimated at around 80 lb N/acre with moderate yields. Adding manure should help offset soil depletion and maintain soil N, and thus soil organic matter and associated beneficial factors. This might be more difficult to accomplish with a manure source like liquid swine manure, which contains little and easily degraded organic material and a large amount of inorganic N, compared to a manure source that has a large amount of difficult-to-degrade organic material (like bedded manure) and low inorganic N. However, liquid swine manure N application should give benefits at least similar to those gained with fertilizer N, but the short- and long-term effects on soil resources is not well documented and difficult to measure.

From the environmental viewpoint, build-up of soil P and nitrate leaching must be considered. If swine manure is applied to both corn and soybean crops in rotation at an N rate for both crops, P is likely to exceed optimum levels for crop production. Soil testing can document this build-up and the Iowa P-Index can help determine potential environmental impact. By using soil testing, P removal by crops, and the P-Index, the application frequency and/or the rate of manure P can be adjusted to supply P needed by crops and keep P loss within acceptable levels. Rate of N application, either from fertilizer or manure, is a key management issue relative to nitrate leaching losses. Compared to no application, applying swine manure to corn or soybean will result in an increase in post-harvest soil nitrate and nitrate concentration in leachate. The response is similar to when fertilizer N is applied. Agronomic guidelines to meet corn N fertilization requirements set the rate to apply and thus dictate potential nitrate loss. Since no N

fertilization requirement (agronomic rate guidance) exists for soybean in Iowa, manure rate guidance could be set several ways.

Currently, IDNR manure planning allows a manure N rate based on 3.8 lb N/bu removed in harvested soybean grain. Based on this rate, the amount of N can become quite high, especially with high-yielding soybean — as high as 200 lb N/acre or more. This is more than the amount of N that soybean typically fixes if no manure is applied. In a corn-soybean cropping rotation, the total N application can be very high (i.e., 200 lb N/acre from manure applied to soybean combined with 125 lb N/acre applied to corn results in a total 325 lb N/acre). In preliminary research results from Iowa State's water quality site near Nashua, a significant increase in tile-flow nitrate has been documented due to high swine manure application rates to both corn and soybean in a corn-soybean crop sequence. In these studies, the rate for corn was at the top end of the currently suggested N rate for corn, 150 lb N/acre, and the rate for soybean was the IDNR allowable rate, 200 lb N/acre. At Iowa State's water quality site near Gilmore City, research has shown a smaller increase in nitrate concentration with a lower application rate (150 lb total swine manure N/acre to both corn and soybean, a total of 300 lb N/acre). Increases in tile-flow nitrate concentration appear to be due to the larger total N application rather than from increased losses between fall manure application and N uptake by soybean compared to corn. For fall manure applied to either corn or soybean, the pattern of tile-flow nitrate concentrations over time in the spring flow appears similar.

If producers do not have the option to apply manure to a soybean crop, then they will apply it either to corn in rotation with soybean or to continuous corn. If it is applied to corn in rotation, then that application will offset fertilizer N. This should result in an overall lower N loading and lower nitrate leaching in the rotation. If producers increase their continuous corn acres in order to accept the manure, then leaching losses will likely be higher than a corn-soybean rotation with N applied to just corn. In a continuous corn system, N is applied every year and the overall two-year application of N is greater — 350 lb N/acre total for two years of corn at 175 lb N/acre each year, the midpoint of the suggested rate for continuous corn.

Alternatives for Manure Rate Guidance

Reasonable alternatives exist that would moderate manure application rates to soybean. One alternative focuses on limiting manure N application to an amount that compensates for N that typically would not be fixed by soybean (and is instead supplied by manure). Depending upon yield level, the amount would be in the range of 100 lb N/acre. Since soybean will compensate through fixation for a shortage of N from the soil or applied manure, having a manure N rate not exactly equal to the total N typically fixed should not affect soybean yield. With implementation of this suggested manure N rate, the two-year corn-soybean rotation would have a total of 225 lb N/acre application. Because this suggested rate is considerably lower than the IDNR rate (yield/removal based), nitrate leaching would be reduced and perhaps result in minimal difference compared to a corn-soybean rotation where N is only applied to corn. Also, manure application implemented at the suggested rate in the soybean year would be expected to result in little increase in residual nitrate in the soil after harvest.

A second alternative would be to base the manure application on the P and/or K requirement of the soybean crop or the two-year corn-soybean rotation. Except in low-testing soils, this would

be a crop harvest removal rate. Based on typical nutrient concentrations in swine manure, the rate would supply less (soybean crop removal only) to approximately the same amount of N (corn-soybean rotation) as the first alternative outlined above. Basing manure application on the P requirement or removal is a reasonable and well-defined approach in soils that test optimum or less for crop production. In high-testing soils, an approach based on P removal also is reasonable from an environmental perspective because the manure application rate will not significantly increase the risk of P loss as long as appropriate application methods and timing are used.