SAMPLE FARM
Nutrient Management Plan

General

Overall, the nutrient management plan for the farm includes these components: 1) use of poultry litter when soil phosphorus (P) content and timing of application relative to harvest permit; 2) use of legume cover crops, both winter and summer annual, for fixation of nitrogen (N) for use by subsequent crops; 3) green manuring with legumes, grasses and forbs to improve soil quality, hence production; 4) rotations to efficiently utilize nutrients and promote crop health; and 5) use of commercially available organic fertilizer materials to meet crops nutrient requirements when necessary (including soluble fertilizers injected into drip lines).

In past years, all of the fields that are in transition to certified organic acreage have been in crop production. Though the exact cropping history is unknown, use of P fertilizer or animal manures containing more P than necessary to supply the need of those crops is not in doubt. As indicated by the Clemson Soil Test Report (see attached report, as well as the attached 2014 Nutrient Management Plan for SAMPLE Farm), almost all fields have excessive P content. The high P levels in fields limits the use of poultry litter to supply N to crops and increases the cost of nutrient management because of the relatively high cost of purchased organic N.

The total acreage in transition to organic on the farm is 28.5 acres. The only residual N credit for the 2014 cropping season is from an early-terminated cereal rye cover crop on four of the fields (please see 2014 Nutrient Management Plan). That credit is 20 lbs/acre of biomass-N from the rye. There were no winter annual legumes (the 2013 fall cover crop was cereal rye), or summer annual legumes grown in 2013. Therefore, in 2014, almost all N required for crops must be supplied by animal manure or by OMRI- (Organic Materials Review Institute) approved fertilizers purchased by the grower. Given the concentration of poultry operations in the South Carolina., the least expensive fertilizer material for providing N, P, and potassium (K) for organic crops is poultry litter. The cost of commercial organic fertilizer makes its use on agronomic field crops problematic (except potassium sulfate), and poultry litter the most feasible and available alternative (compost would be an option if it was available and transportation costs economic). In addition to supplying N (57.8 pounds of total N per ton of broiler litter), litter also supplies P (40 lbs of total/plant available P per ton) and K (48.6 lbs of total/plant available K per ton). Broiler litter is available nearby the farm. The grower should request a waste analysis of any animal manure used on the farm and adjust litter application rates based on N, P and K content of that particular material. The Clemson Analytical Lab can perform that analysis.

Excessive P reported in the soil test results suggested that a Phosphorus Index (PI) calculation be conducted on all farm fields. The results are shown in the attached table, South Carolina Phosphorus Index Risk Rating: Nutrients. That table rates risk *for each field in each year* in both the "Crops" and "Vegetable" rotations where litter is proposed as a nutrient source for the crop. The letter (*a, b, c*….) following the field number designates the year in the rotation where a litter application is planned. Where PI risk ratings limit P application rates to either P removal rates, those rates are drawn from the attached "P Removal Rates of SAMPLE Crops." Removal rates reflect total P removal for both crops in a double-cropping situation.

The risk ratings for 2014 are affected by higher N needs of crops due to the preceding winter cover, cereal rye, which is assumed to provide little available N to the 2014 cash crop. In subsequent years,

winter annual legumes provide available N, which results in lower recommended N application rates and consequently lower assumed P application rates.

Risk ratings after 2014 assume that soil availability of P remains at 2014 levels as represented by the Clemson Agricultural Services Laboratory Soil Test Results. This is obviously does not represent real changes in P availability that will take place over time as the effect of litter/fertilizer applications affect soil test results. Annual soil tests are recommended, and the PI calculations recomputed in each subsequent year.

Litter applications are planned for corn and sweet potatoes in the "Crops" rotation in 2014 following termination of the 2013 cereal rye crop. In the "Vegetable" rotation, litter applications are recommended for sweet corn, bell pepper and watermelon in 2014. Please see the following worksheets for nutrient management information: 2014 Nutrient Management Plan for SAMPLE Farm, Crops Rotation and Cover Cropping Plan for SAMPLE Farm and Vegetable Rotation and Cover Cropping Plan for SAMPLE Farm. The latter two worksheets make recommendations on nutrient management for every year in the respective crops and vegetable rotations. The "revised litter per P risk" data in those two worksheets determine whether litter application at agronomic rates is possible. Note that in some instances, proposed litter application rates are below two tons per acre. The current equipment available for spreading litter cannot apply and distribute litter uniformly below this threshold. Where recommended litter application rates fall below this level, the use of commercial fertilizers rather than litter is advised.

Litter will be applied to Field 9a, which will be sprigged with coastal bermudagrass following incorporation of the litter. Field 9b will also be sprigged, but no litter will be applied because Big Branch creek, which meanders centrally through that small, 0.5 acre field.

Site vulnerabilities for fields potentially receiving litter in 2014 crops are shown below. Note that in some instances, litter applied at a rate to supply total N needs of crops would increase the P risk index to PI-2. In order for some of these fields (2a, 5a, 5b, 6, 8a and 8b) to achieve a PI-1 risk rating, litter rates were reduced until the PI rating value fell below the PI-2 threshold. Necessarily, those fields will receive both litter and commercial organic N.

Field	Site Vulnerability Rating	Crop	Controlling Nutrient
1a	PI-1	Sweet corn	N
1b	PI-1	Bell pepper	N
2a	PI-1	Watermelon	N
3b	PI-3	Tomato	1*P
5a	PI-1	Corn grain	N
5b	PI-1	Corn grain	N
6	PI-1	Wheat	N
7a	PI-3	Canola	1*P
7b	PI-3	Canola	1*P
8a	PI-1	Sweet potatoes	N
8b	PI-1	Sweet potatoes	N
8c	PI-1	Sweet potatoes	N
9a	PI-1	Bermuda	N
9b	PI-1	Bermuda	N

For vegetable crops, use of litter provides some constraints on management. Use of animal manures on crops destined for human consumption cannot be applied within 120 days of harvest, where the harvested portion of the crop is "likely" to come into contact with manure (by wind, water, or soil). Where edible, harvested crops are not likely to come into physical contact with manure constituents, manure cannot be applied within 90 of harvest of the edible part of the crop.

Vegetable crop fields can also have N requirements met with feather meal (13-0-0) or other commercially available organic fertilizers. Feather meal is the least expensive organic N source (cost per unit N) as of this writing. Where commercially available N is recommended in the tables attached to this nutrient management plan, application rates are provided for feather meal (13-0-0). If other commercial N sources are used, application rates will need to be adjusted to reflect the N content of those particular fertilizer materials (multiply the recommended total N rate by 100 and divide the total N content of the chosen fertilizer to derive the adjusted rate).

Nitrogen application rates for vegetable crops in this plan are based on Clemson University recommendations, which can be found at:
http://www.clemson.edu/public/regulatory/ag_svc_lab/soil_testing/downloads/vegetables.pdf.
Nitrogen recommendations are based on research for crops produced conventionally and in some cases rates may be reduced on higher "quality" soils. Nitrogen application rates for agronomic crops are drawn from the Clemson recommendations, which can be found at:
http://www.clemson.edu/agsrvlb/new_page_16.htm

Fertilizer P and K are often referred to as P_2O_5 and K_2O. For purposes of this report, fertilizer P_2O_5 and K_2O will be referred to as "P" and "K". The same is true of the worksheets included. The Clemson soil test report makes P and K recommendations for vegetable crops based on soil P and K test results (low, medium, high, very high or excessive categories). The 2014 P and K recommendations in this report are based on Clemson soil test results for P and K (see soil test reports). Whereas most fields were "excessive" in P content and Clemson recommendations call for no P fertilizer, most fields were only "moderate" in K content and substantial K fertilizer is recommended.

An eight-year rotation is suggested for vegetable crop production. Crops rotate through eight one-acre fields. The vegetable crop fields are primarily on Johns fine sandy loam, the most productive soil on the farm. The vegetable rotation is sweet corn, bell pepper, watermelon, kale, lettuce/okra (doublecrop), tomato, cucumber, Irish potato/collards (doublecrop). The peppers, watermelon, lettuce/okra, and tomatoes are on plastic mulch with drip irrigation. Okra follows lettuce on the same plastic-covered beds. A four-year rotation is suggested for agronomic crop production on Leaf and Wahee fine sandy loam soils. The fields in agronomic crop production vary in size and are somewhat a "patchwork" of fields, but in any given year there is approximately 3.5 acres in a particular crop. The crop rotation calls for corn for grain, wheat, canola, beans, and sweet potatoes. All vegetable and agronomic crops are represented on the farm in all years.

Nutrient management plans for 2014 are presented in the attached table "2014 Nutrient Management Plan for SAMPLE Farm" and "High Tunnel Nutrient Management Plan for SAMPLE Farm." For both the vegetable and agronomic crop rotations, additional nutrient recommendations for years following 2014 are presented in the attached tables "Vegetable Rotation and Cover Cropping Plan for SAMPLE Farm," and "Crops Rotation and Cover Cropping Plan for SAMPLE Farm." The rotation plan for the high tunnel can be seen in the "Rotational Plan for SAMPLE High Tunnel." These tables present the entire rotation

schemes for the rotations, including winter and summer cover crops, and make estimations of the contributions of cover crops to crop N requirements. While they present both litter and feather meal options for supplying projected crops' nutrient needs for all years in the rotation, those options will need to be adjusted based on future soil test P and K, as well as soil P index calculations.

It should be noted again that Phosphorus Index (PI) calculations vary by soil test P, proposed P application rate and the particular soil characteristics in each field. In most cases, the proposed N application rate for each crop in each rotation post-2014 is lower than application rates derived from initial PI values calculated for 2014. This is primarily because the use of legume cover crops contributes N to crop needs, reducing proposed 2014 litter application rates, hence P application rates, in years 2015 and out (there is no legume contribution to crop nutrient needs in 2014). As proposed P application rates decline with lower litter application rates, the PI value and phosphorus vulnerability may also decline, though neither does in every case.

The proposed litter application rates in the tables reflect the changing soil characteristics (depth to groundwater and subsoil permeability), crop nutrient requirements for N and P and application methods (broadcast versus incorporation) as crops progress through the proposed rotations. However, these recommendations do not reflect any changes to soil test P in years beyond 2014. All nutrient application recommendations in 2015 and beyond are based on 2014 soil test P. Therefore, the PI should be recalculated each year based on soil test P results obtained in that year. Since organic certification requires an annual soil test, his recalculation should not be a hardship.

As use of legume cover crops begins in the summer and fall of 2014, initial application rate recommendations for litter on sweet corn, peppers, watermelon tomatoes and all agronomic crops will decline. Consequently PI values will also decline and litter application rates may be controlled by N rather than by P. Where PI values remain high, the grower has the option of "harvesting" the cover crops to remove P from fields that have excessive P values. However, this will result in additional N needs for crops from some other source. If that source is litter, then there may actually be a negative consequence (PI increases) from the use of that litter, despite the additional P removal.

There are some important points to consider when using these tables. The biomass produced by a cover crop is a best estimate drawn from research and experience. Biomass produced will vary by production year, weather, planting date and termination date. Plant "available" biomass-N is estimated at two percent of biomass (1% biomass of sorghum sudangrass and buckwheat). This is a rough estimation of "available" N in the biomass (not total N, which is likely to be twice these values). Winter annual biomass production assumptions may differ markedly from actual production and from RUSLE2 default values. Summer annual grass cover crops are expected to contribute little to available N for subsequent crops, but they do function as a trap crop for nutrients that would otherwise be lost from the system by leaching and other means.

The grower can get a better estimate of the "available" biomass N per acre at cover crop termination by having a plant sample analyzed for N content at the Clemson Agricultural Service Lab. Annual legumes typically have between 3.5 and 4 percent N in their aboveground parts prior to flowering (for young material, use the higher end of the range), and 3 to 3.5 percent at flowering. After flowering, N in the leaves decreases quickly as it accumulates in the growing seeds.

The percent N determined by the lab is multiplied by the "dry" biomass produced in one acre in that field. Biomass can be calculated by taking a nine square foot biomass sample (3' X 3'), drying the

biomass collected, weighing the dried sample and multiplying the dried weight X 4840. Percent N multiplied by pounds of dry biomass per acre provides a relatively good estimate of the "total" biomass-N provided by the cover crop on a per acre basis. However, total biomass-N will have to be adjusted to reflect how much of that total biomass-N is "available" to the following crop. This adjustment will vary depending on the stage of growth of the cover crop at termination, climate, soil moisture and other factors.

Alternatively, a rough rule thumb is that at 100% groundcover and six inches height, cover crop biomass (dry weight) is approximately 2000 lbs/acre. For each additional inch of height add another 150 pounds of (dry) biomass per acre.

When a summer cover crop is grown, but is not followed immediately by a cash crop, the plant-available biomass-N produced by a summer legume is considered to be 50% available for both the agronomic crop and the vegetable crop grown in the subsequent year. Biomass-N provided by summer annual cover crops is considered to reside over winter in the soil ecosystem (as organic- and microbial biomass-N) and contribute to soil quality conditions (physical, chemical and microbial).

Currently, twenty percent of the N applied to crops can be applied as sodium nitrate (currently under review by the National Organic Standards Board). This material may be prohibited in the future. Sodium nitrate (aka "bulldog" of soda) is a soluble material and can be injected through drip line for vegetable crops. Pre-plant N application rates of feather meal or litter may be reduced if this material is used as a sidedressing after planting or in drip systems. It may be particularly useful in the lettuce/okra doublecrop component of the vegetable rotation, as the okra is double cropped on the plastic following lettuce. In this plan, all the N for both crops is applied before the plastic is laid, and a better option would be to supply some of the N for the okra through the drip lines. Sodium nitrate is an important component of the SAMPLE Farm High Tunnel Nutrient Management Plan. Twenty percent of the N requirement for the high tunnel tomato crop is supplied through drip irrigation lines by sodium nitrate.

All rates recommended in this report are subject to change (decrease) as soil fertility and quality improves over time. Always use OMRI-approved materials as soil amendments. If there is any question about the use of an amendment for certified organic production, check with the appropriate certifier for approval. Before using any "new" material, contact the certifier to add the use of the material to the organic system plan.

Comments on Specific Fields for 2014

In Fields 1a and 1b (sweet corn and bell pepper) litter is applied to meet all the N and P needs of the crops in 2014. Litter will be incorporated within 24 hours after application. The N availability coefficient representing "plant available N" in the litter (PAN) is 0.6 (incorporated within 24 hours). Applications of litter are planned for 90 days before harvest of these crops. See the RUSLE2 Management Report for Eight Year Vegetable Rotation for details on timing of management practices.

In Field 2a (watermelon), litter will be surface broadcast to a growing winter cover crop (cereal rye) in 2014. The availability coefficient for calculating the plant available N (PAN) in the litter has been reduced from 0.6 to 0.5. Litter application is not limited by site vulnerability, and litter will be applied to meet N requirements of the watermelon crop. Note that equipment is not available to accurately apply litter at a 1.7 tons/acre rate, so the grower should elect to fertilize with feather meal (13-0-0). No application of litter is planned for Field 2b (kale), because it is planted so early in the season.

In Field 3a, there is a planned double crop of spring lettuce followed by okra on black plastic. No litter is planned for this doublecrop in in any year in any field in the rotation because of the earliness of the lettuce crop and the difficulty in applying litter (or any "solid" N fertilizer) to crops once plastic has been applied to beds. The recommendation in this plan is to apply the entire N required for both crops before laying the plastic (200 lbs N or 1,538 lbs feather meal/acre). This is a considerable amount of N (and cost/acre) to apply at one time on a fine sandy loam (although leaching is less of a potential problem underneath the plastic and feather meal is somewhat of a "slow release" fertilizer). A better alternative (if the certifier will permit it) for meeting nutrient needs of the okra, in particular, is to apply 20% of the N requirement for the double crop as sodium nitrate (bulldog of soda, 16-0-0). Twenty percent of 200 lb/ac N translates into 40 lbs of N. Forty lb/ac N translates into 250 lb/ac "bulldog" (40 X 100 divided by 16). Given this alternative, the application rate of feather meal would be reduced by 20%, from 1,538 lbs/acre to 1,230 lbs/acre. The "bulldog" can be injected through the drip lines to supplement N needs of the okra.

Field 3b is planned for tomatoes in 2014. Based on the PI for that field (PI-3 rating), litter application is only permitted 1*P removal rates. This rate cannot be applied with the equipment available to the producer. All N will be supplied by feather meal as per the attached tables.

The grower should request a waste analysis of any animal manure used on the farm and adjust litter application rates based on N, P and K content of that particular material. The Clemson Analytical Lab can perform that analysis.

Fields 4a and 4b will receive their total N requirement from commercial fertilizer. These fields are in cucumbers and Irish potatoes, respectively, in 2014. Both crops would have to have any litter applied at least 120 of crop harvest. Management options are limited in applying litter this early in the season to either crop.

Interestingly, even though Fields 5a and 5b (corn for grain) have "low" soil test P and P fertilizer is recommended, litter application rates are limited by the Phosphorus Index rating. A litter application rate to meet the N requirements of corn would oversupply P and bump the PI rating from PI-1 to PI-2. Litter application would be limited to the P removal rate at PI-2, or 42 lbs/acre. Litter cannot presently be applied at this rate (approximately one ton per acre) with equipment currently available. For this reason, the litter rate was dialed back until rate reached a level where the P applied resulted in a PI-1 risk rating. The litter rate that corresponds with this calculated risk level, 2.9 tons/acre, will therefore not supply the total N requirement of the corn crop, but it will supply the p called for in the Clemson soil test report. Wheat is planted in these fields in 2014 after a cowpea summer cover crop. The cowpeas will provide sufficient N for fall N requirements of the wheat (20 lb/ac).

Field 6 is "scheduled" to be in overwintering wheat in 2014. This is basically a placeholder in the planned rotation, as no wheat was planted in that field in the fall of 2013. Necessarily, no application of litter will need to be made. In the fall of 2014, Field 6 will be planted to canola following a summer cover crop of a soybean/ millet biculture. The summer cover will supply the entire fall nutrient requirement for the canola, and residual biomass-N provided by that summer cover will contribute to the spring N requirement of the overwintering canola. Note that in the attached tables an additional 30 lb/ac N in included in the spring N recommendation for the canola (normally 90 lb/ac) to provide starter N for the following dry bean crop (or, alternatively, soybean crop).

Fields 7a and 7b, similarly to the situation described above in Field 6, are "scheduled" to be in overwintering canola in the spring of 2014. Again, this is basically a placeholder in the planned rotation, as no canola was planted in those fields in the fall of 2013. Litter applications are ruled out for canola, because in all fields the P risk rating (PI-3) limits litter application to the P removal rate of the doublecrop in that field, canola and beans. While this rate is relatively high (59 lbs/acre), it equates to about 1.5 tons of litter per acre (not a feasible application rate). Necessarily, no application of litter will need to be made.

Fields 8a, 8b and 8c will be planted to sweet potatoes in 2014. Fields 8a and 8b are limited with respect to litter application in 2014 by the PI. Field 8c applications of litter are permitted at rates calculated to meet the N application requirement, but like fields 5a and 5b litter rates are reduced somewhat to keep field risk at PI-1. Litter will be incorporated at least 120 days before the expected harvest date. Additional N required for sweet potato production will be supplied by OMRI-approved commercial organic fertilizer in 2014. Note that 2014 is the only year in which litter will be applied to fields planted to sweet potatoes. In subsequent years, all of the N needs of the sweet potatoes will be met by a preceding winter annual legume/grass biculture and an assumed contribution of 20 lb/ac of N from the preceding bean crop. This is shown in the worksheets as a negative "additional N requirement."

Field 9a and 9b are planned for livestock production. They will be planted to coastal bermudagrass in the spring of 2014. Both fields allow for litter application rates based on N requirements of the bermudagrass (PI-1). However, since the perennial stream 'Big Branch' runs through the middle of Field 9b, the recommendation here is that no litter be applied to that field. In fact, the only reason for the "existence" of Field 9b is to protect that stream from any negative effects from litter application in Field 9a and to exclude any livestock. The producer may want to consider Conservation Practice Fence (CP 382), to protect Big Branch.

The High Tunnel Nutrient Budget Worksheet provides a variety of choices for managing N in the high tunnel. Litter is not one of those options. The grower should sidedress with OMRI-approved N-supplying fertilizers at rates recommended in the tables. Rates are based on rows that are four feet apart and beds four feet wide in the tunnels and are provided in lb/100 row feet and lb/100 square feet.

Every other year, a summer cover crop (forage soybean and Japanese millet) will be grown in the high tunnel. This activity, which will generate approximately 80 lbs/acre biomass-N, will require the installation of microsprinklers for irrigation. As the sidewalls will be up while the crop is growing, measures should be taken to ensure that deer do not damage the crop. Compost will be applied in the fall of every year to enhance soil quality.

Soil pH in most fields is in the appropriate range for production of agronomic and vegetable crops. Fields 5b and 9b require 1.3 and 1.8 tons/acre lime, respectively, to bring soil pH to recommended levels.

Boron (B) is recommended as a component of the pre-plant fertilizer application for most vegetable crops at 1 to 2 lbs/acre (excepting bell pepper, watermelon, cucumber and potato in this rotation). One pound of B and zinc (Zn) per acre is recommended for corn. See Clemson soil test results for additional minor nutrient recommendations and the attached table "Micronutrient recommendations."

Clemson University reports the following state requirements for setbacks manure utilization areas: **(**www.clemson.edu/extension/livestock/camm/camm_files/manure_broker.htmlrecommendations:

- The minimum separation distance in feet required between a manure utilization area and a residence is located is 300 feet. If there are no residences within 300 feet of the manure utilization area, manure may be utilized up to the property line. The setback may be waived with the written consent of the owner of the residence. If the application method is injection or immediate incorporation, manure can be utilized up to the property line.
- The minimum separation distance in feet required between a manure utilization area and waters of the State (including ephemeral and intermittent streams) is 100 feet when dry manure is spread on the ground surface, 75 feet when incorporation is the application method, and 50 feet when injection is the application method. When incorporation is accomplished within twenty-four hours of the initial application, the distance can be reduced to 50 feet.
- The minimum separation distance in feet required between a manure utilization area and ditches and swales that discharge to waters of the State including ephemeral and intermittent streams is 50 feet.
- The minimum separation distance in feet required between a manure utilization area and a potable drinking water well is 100 feet.

These setbacks will impact litter application on fields that are rented from nearby property owners; in particular from wells situated at owner home sites. Those are Fields 3a, 3b, 4a, 4b, 7a, 7b, 8b and 8c. The producer can request waivers from property owners with respect to setbacks from property lines. The setbacks are shown on the conservation plan map as circles defining the perimeter of the 100 foot setback. This assumes the producer has permission, which is likely. Otherwise, setbacks will be 300 feet.