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(54) **METHOD AND SYSTEM FOR LICENSING BY LOCATION**

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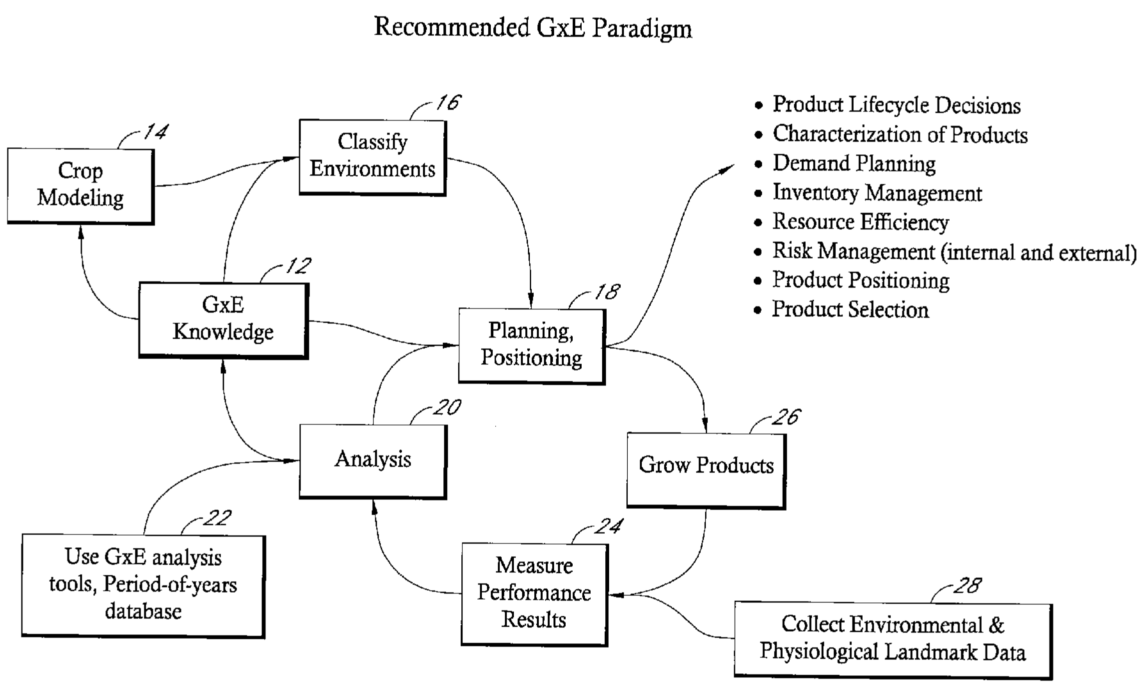
G06Q 99/00 (2006.01)

(52) **U.S. Cl.** **705/1**

(57) **ABSTRACT**

An agricultural input supplier can provide seed products by tying the compensation received for the seed products to an evaluation of the land base on which the seed products are to be planted and/or the performance of the seed products on the land base. The evaluation of the land base may be based on environmental classification and/or genotype-by-environment data. In addition to tying the compensation to the land quality and the seed performance, this approach to providing seed allows for recommendations to be made to the producer regarding which seed products should be used on the land base. The performance of the seed product on the land base may also be verified.



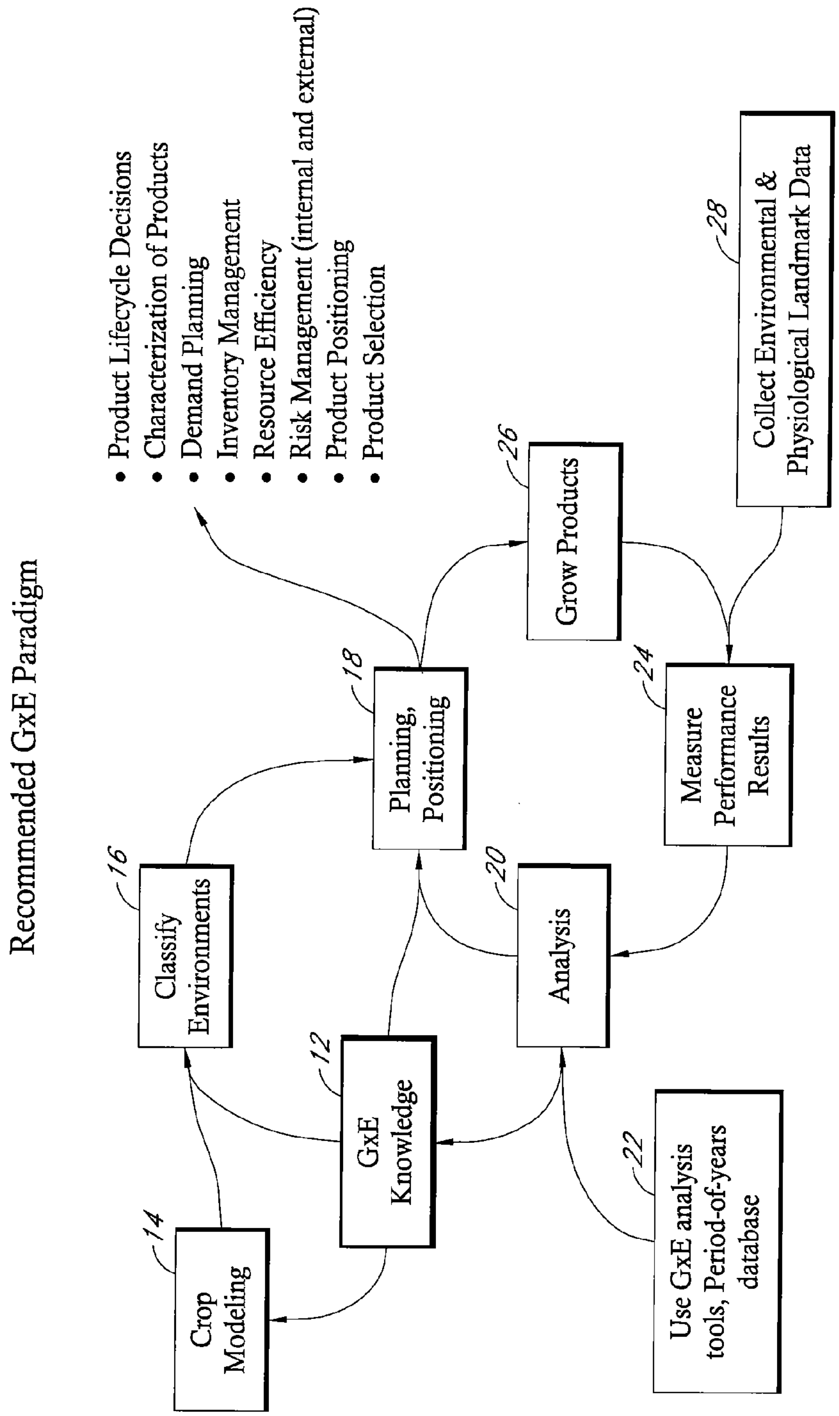

Recommended GxE Paradigm
Product Lifecycle Decisions
Characterization of Products
Demand Planning
Inventory Management
Resource Efficiency
Risk Management (internal and external)
Product Positioning
Product Selection
12
GxE Knowledge
14
Crop Modeling
16
Classify Environments
18
Planning, Positioning
20
Analysis
22
Use GxE analysis tools, Period-of-years database
24
Measure Performance Results
26
Grow Products
28
Collect Environmental & Physiological Landmark Data

FIG. 1

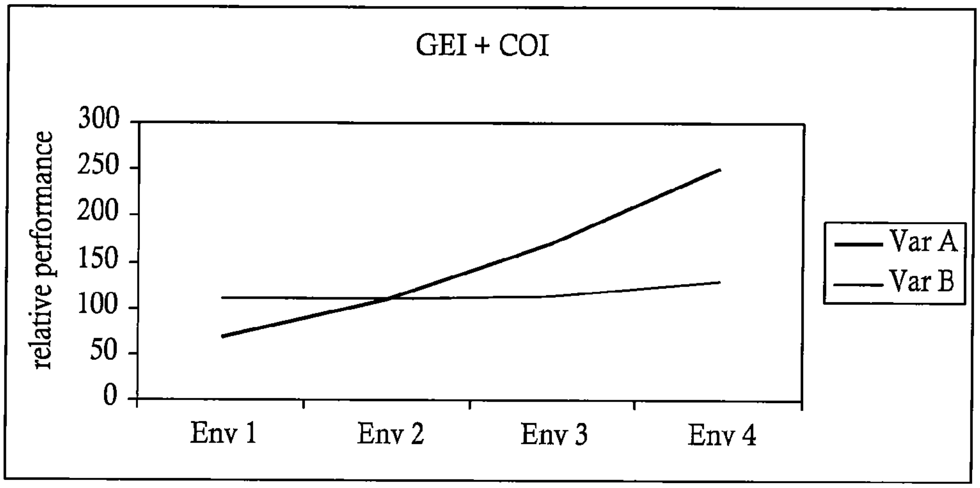


FIG. 2A

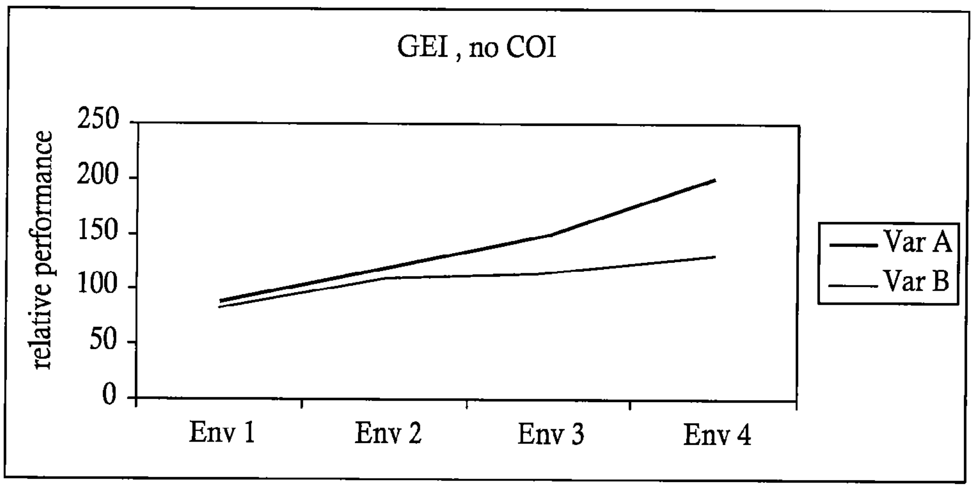


FIG. 2B

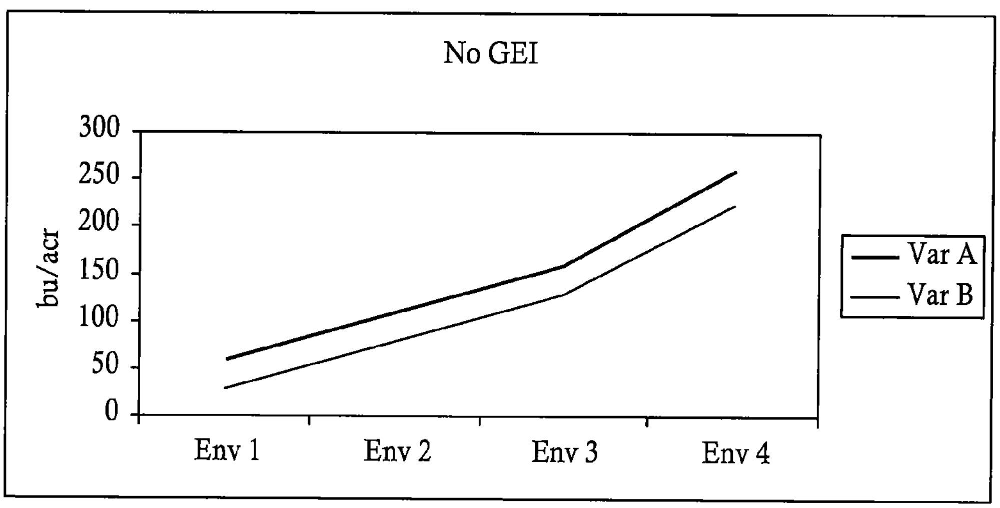


FIG. 2C

Environment-standardized GGE biplot of grain yield of 18 maize hybrids (H1-H18) grown in 266 environments over three years, stratified by state

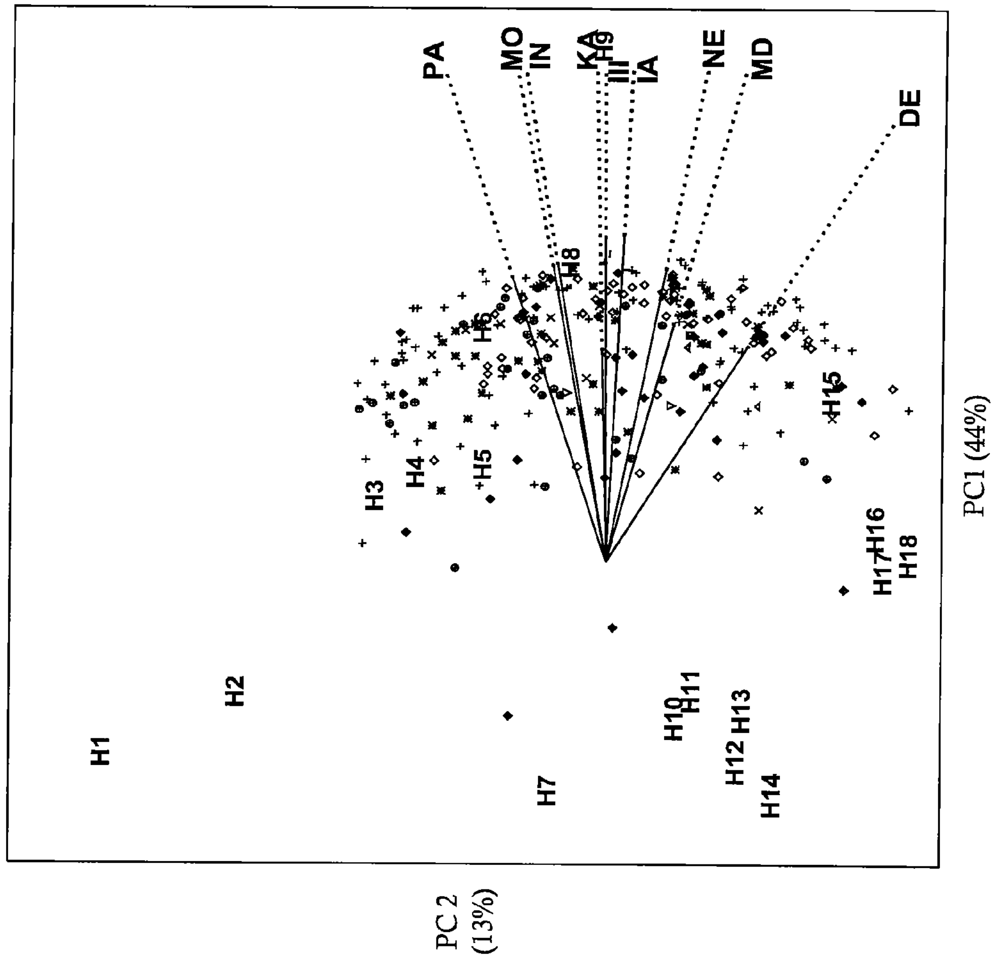


FIG. 3

Environment-standardized GGE biplot of grain yield of 18 maize hybrids (H1- H18) grown in 266 environments over three years, stratified by environment class

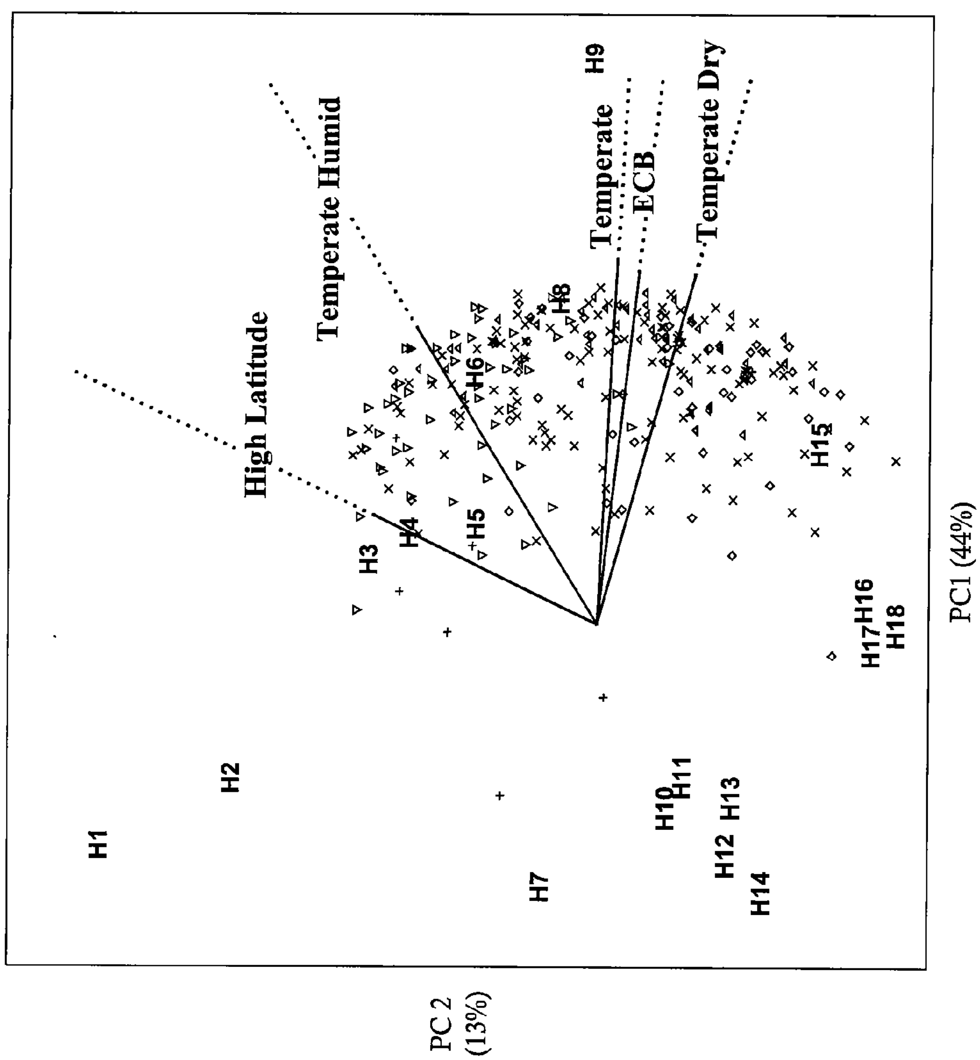


FIG. 4

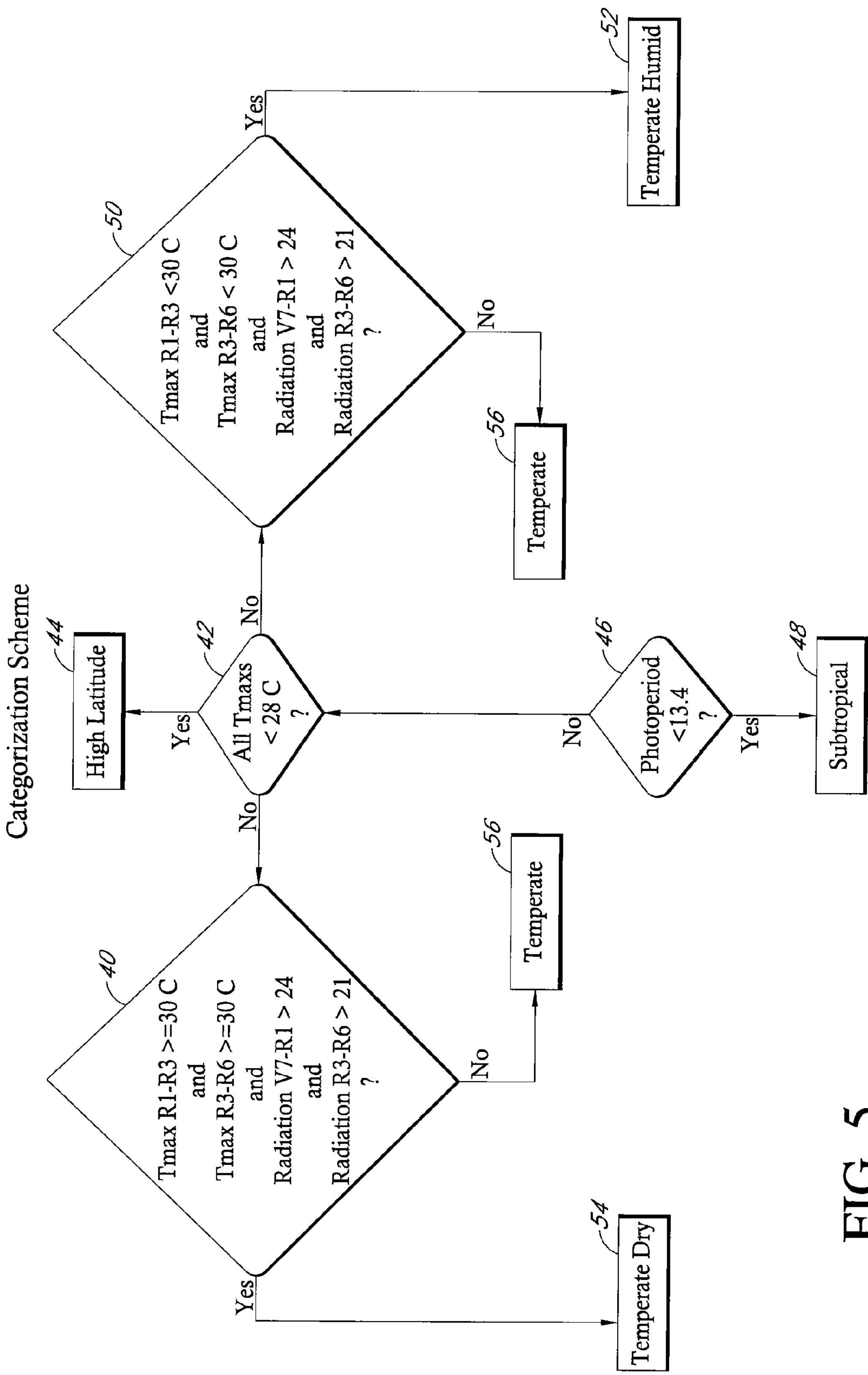

Categorization Scheme
All Tmaxs < 28 C ?
42
Yes
High Latitude
44
No
Tmax R1-R3 >=30 C and Tmax R3-R6 >=30 C and Radiation V7-R1 > 24 and Radiation R3-R6 > 21 ?
40
Yes
Temperate Dry
54
No
Temperate
56
Tmax R1-R3 <30 C and Tmax R3-R6 < 30 C and Radiation V7-R1 > 24 and Radiation R3-R6 > 21 ?
50
Yes
Temperate Humid
52
No
Temperate
56
Photoperiod <13.4 ?
46
Yes
Subtropical
48
No

FIG. 5

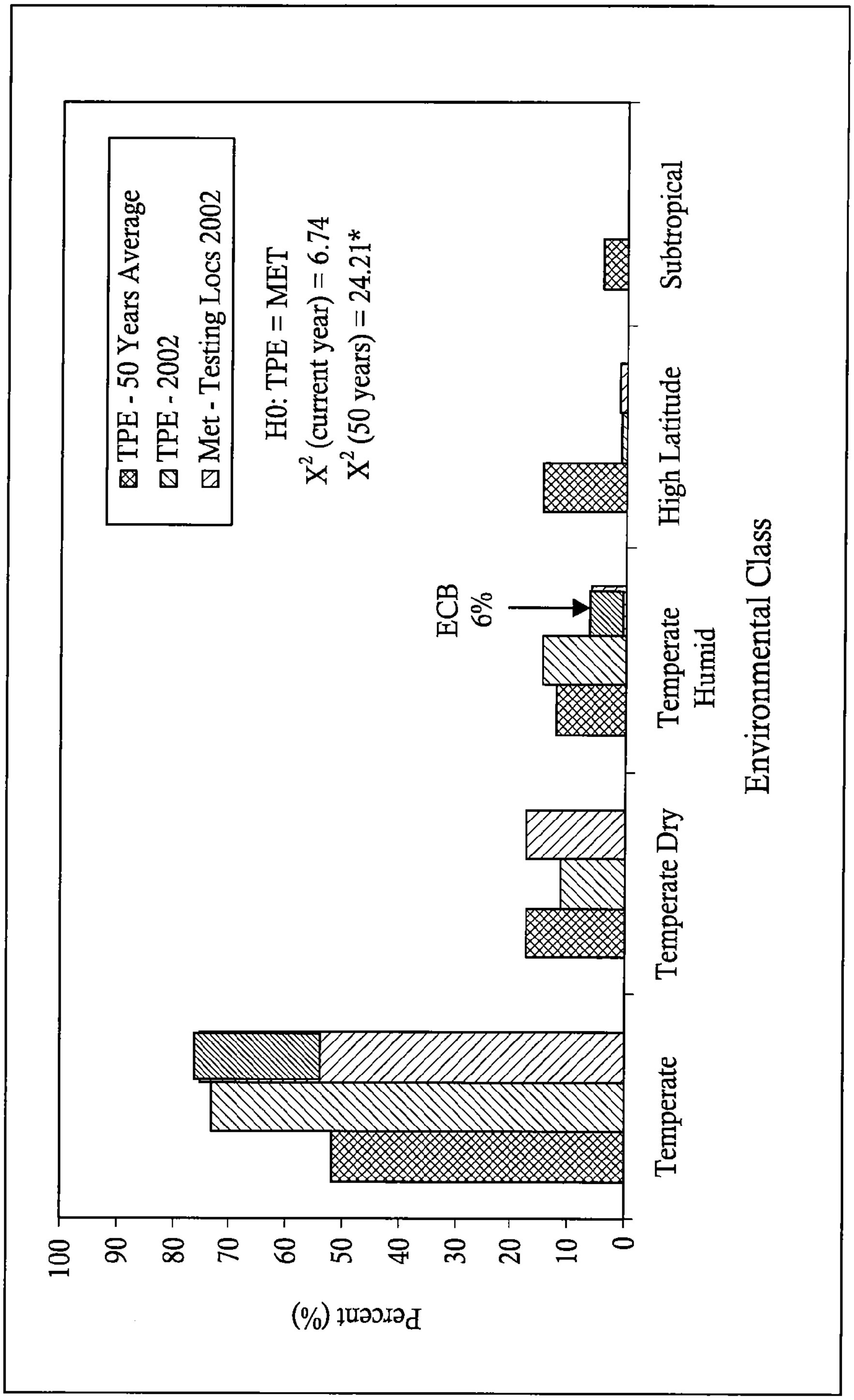
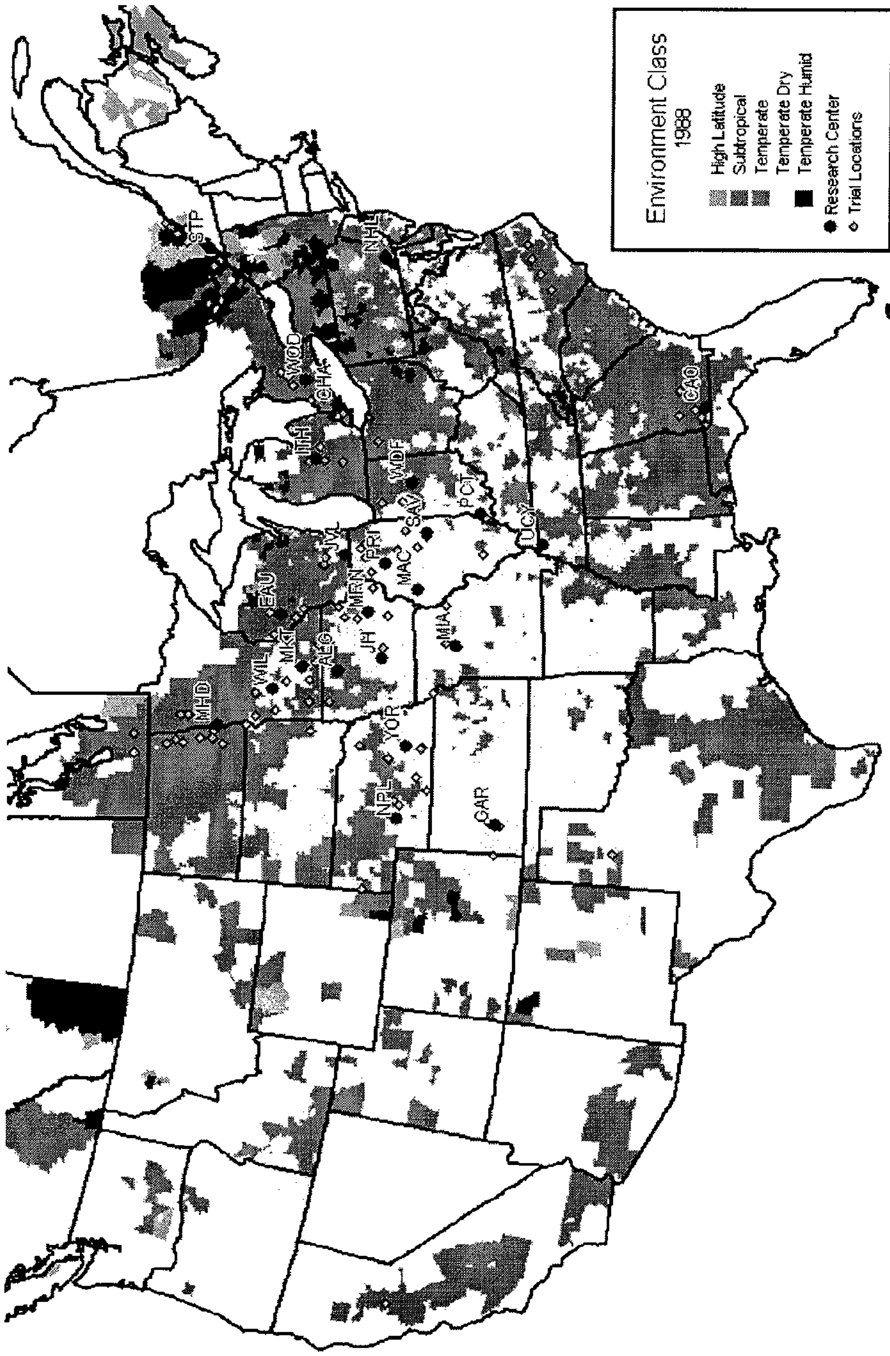

Environment Class Frequency
CRM 103
TPE - 50 Years Average
TPE - 2002
Met - Testing Locs 2002
H0: TPE = MET
X² (current year) = 6.74
X² (50 years) = 24.21*
ECB
6%
Percent (%)
100
90
80
70
60
50
40
30
20
10
0
Temperate
Temperate Dry
Temperate Humid
High Latitude
Subtropical
Environmental Class

FIG. 6



Research Centers and Environment Class
1988

FIG. 7

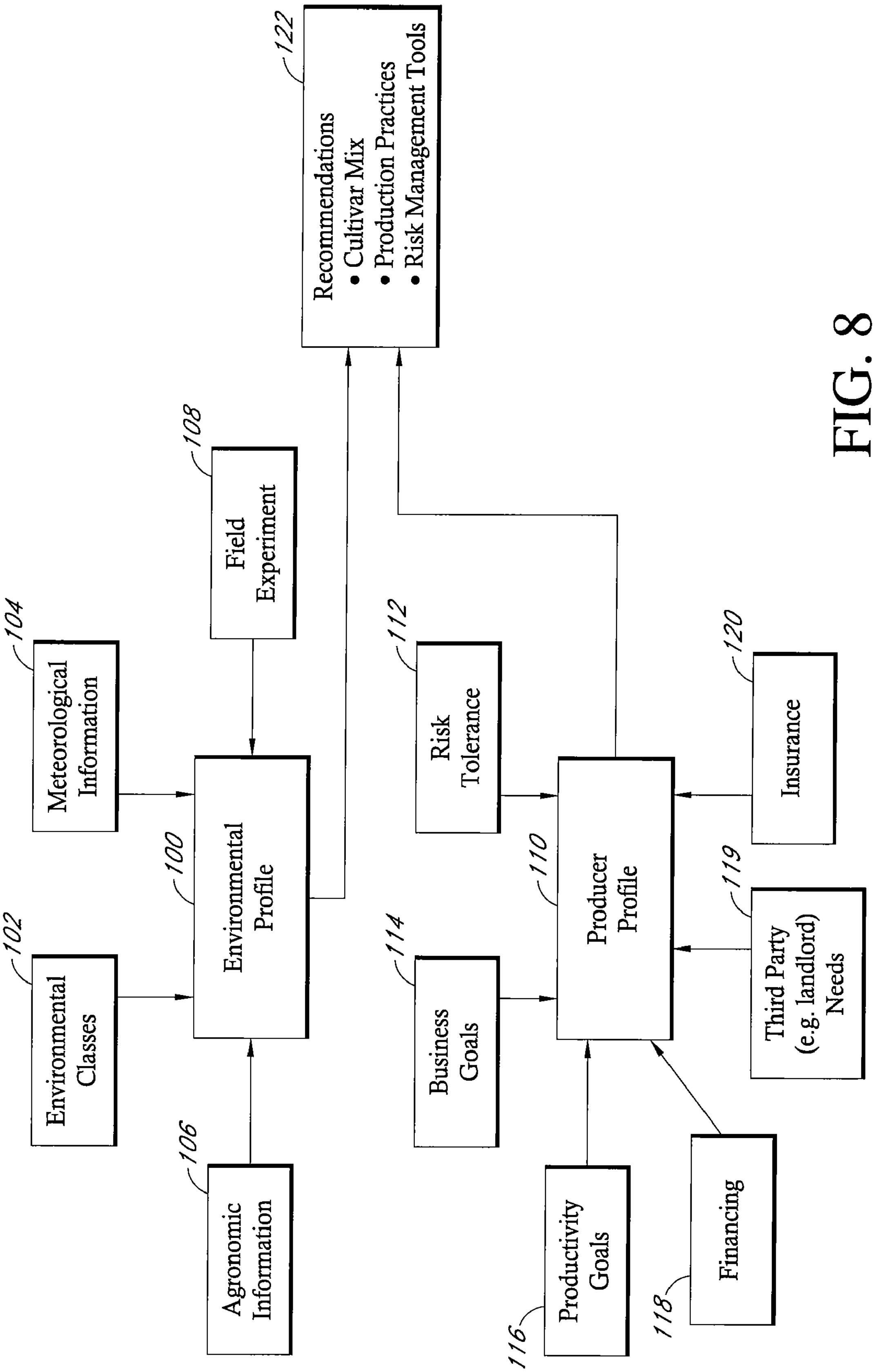

122
Recommendations
• Cultivar Mix
• Production Practices
• Risk Management Tools
104
Meteorological Information
108
Field Experiment
102
Environmental Classes
100
Environmental Profile
106
Agronomic Information
112
Risk Tolerance
120
Insurance
110
Producer Profile
114
Business Goals
119
Third Party (e.g. landlord) Needs
116
Productivity Goals
118
Financing

FIG. 8

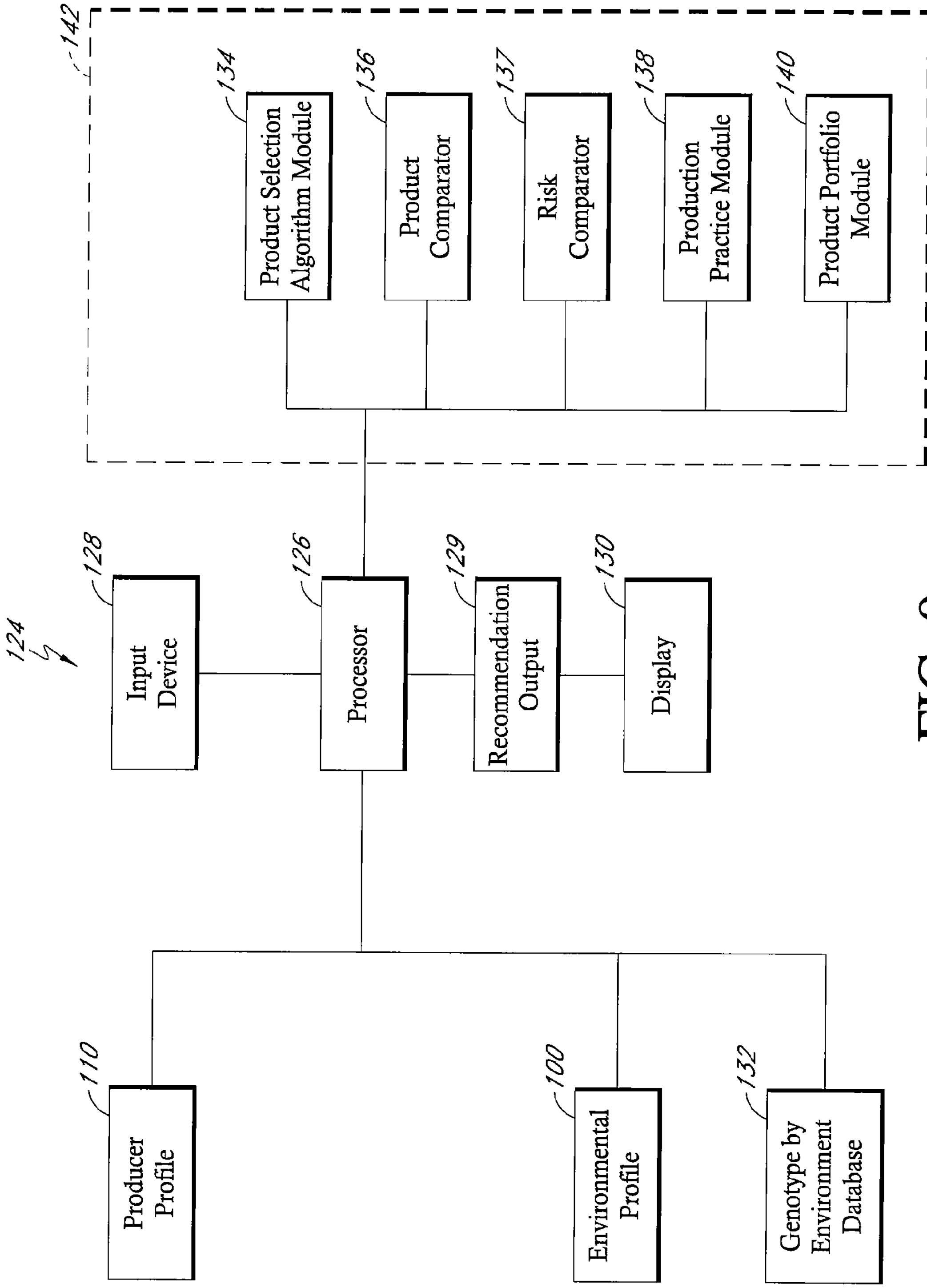

142
134
Product Selection Algorithm Module
136
Product Comparator
137
Risk Comparator
138
Production Practice Module
140
Product Portfolio Module
124
128
Input Device
126
Processor
129
Recommendation Output
130
Display
110
Producer Profile
100
Environmental Profile
132
Genotype by Environment Database

FIG. 9

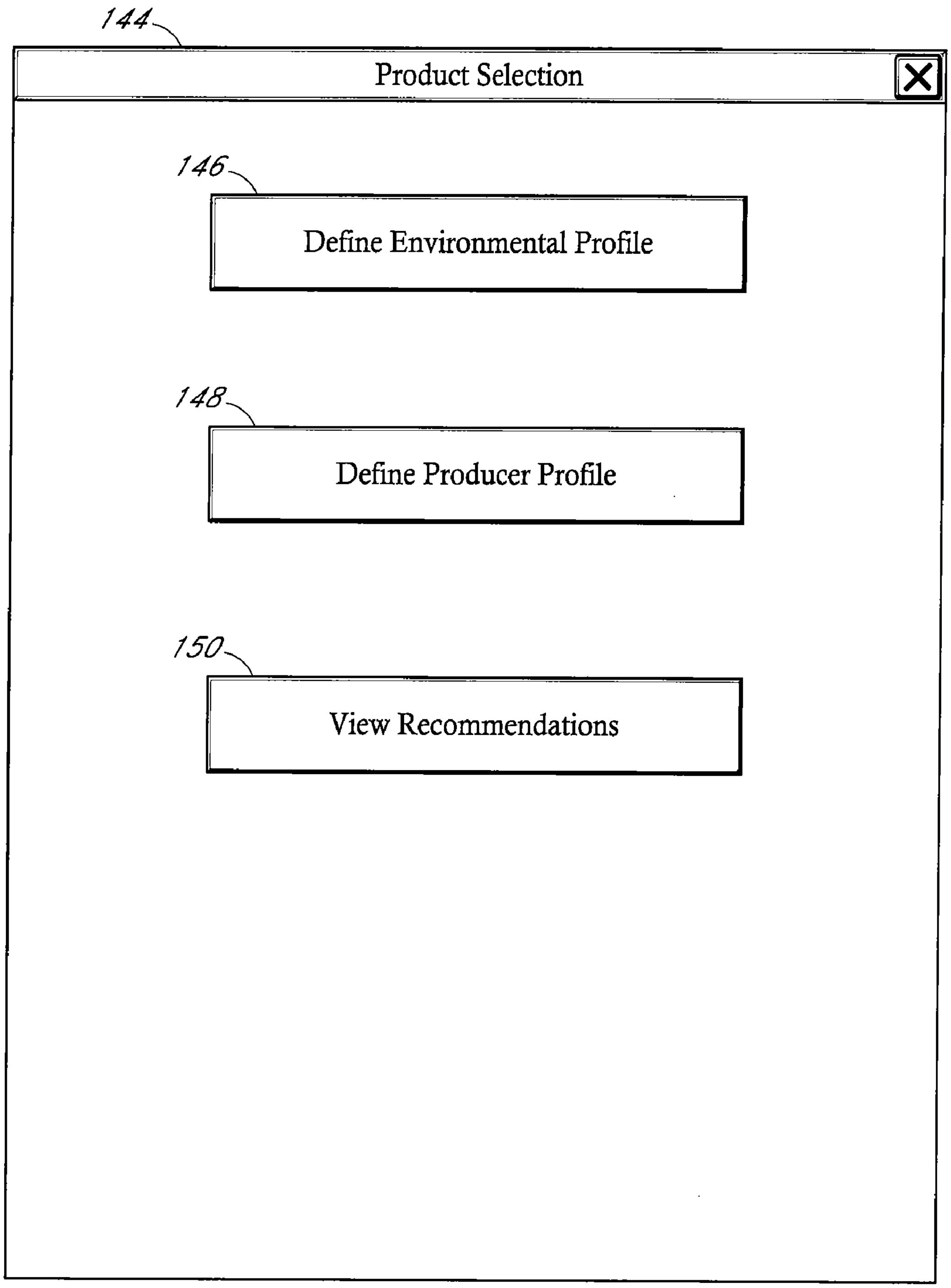

144
Product Selection
146
Define Environmental Profile
148
Define Producer Profile
150
View Recommendations

FIG. 10

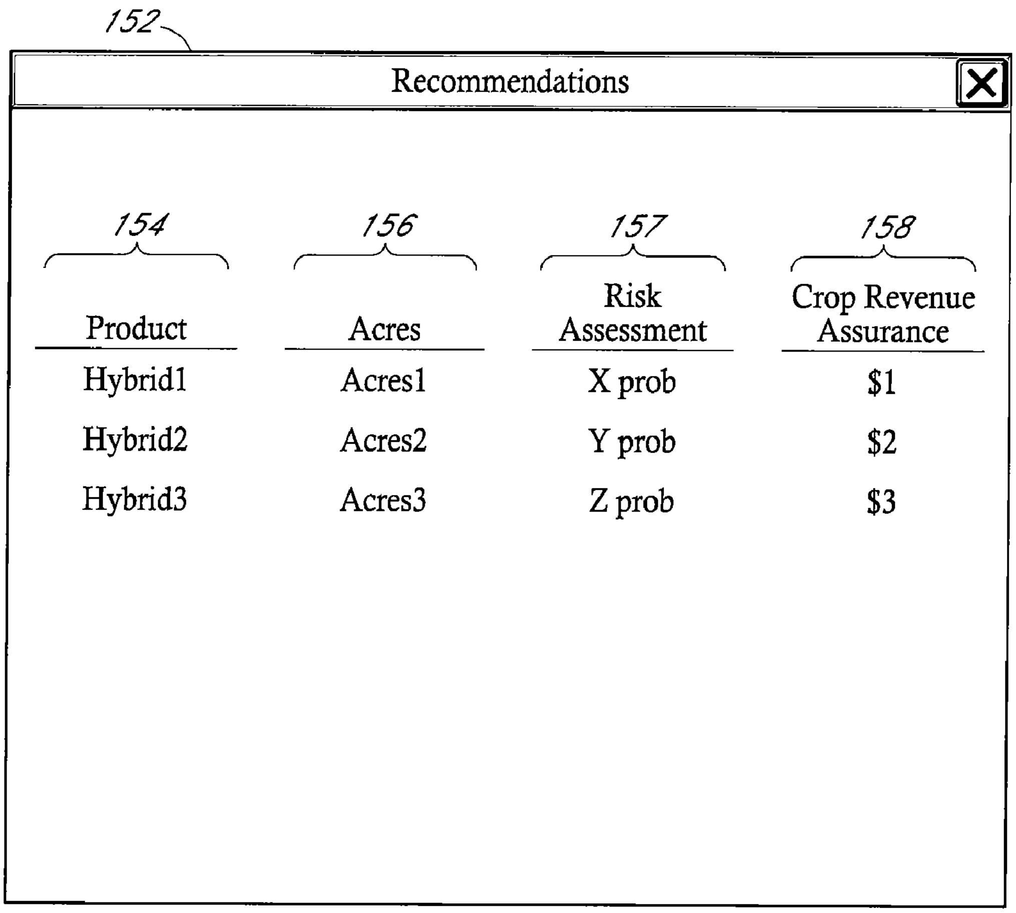

152
Recommendations
154
156
157
158
Product
Acres
Risk Assessment
Crop Revenue Assurance
Hybrid1
Acres1
X prob
$1
Hybrid2
Acres2
Y prob
$2
Hybrid3
Acres3
Z prob
$3

FIG. 11

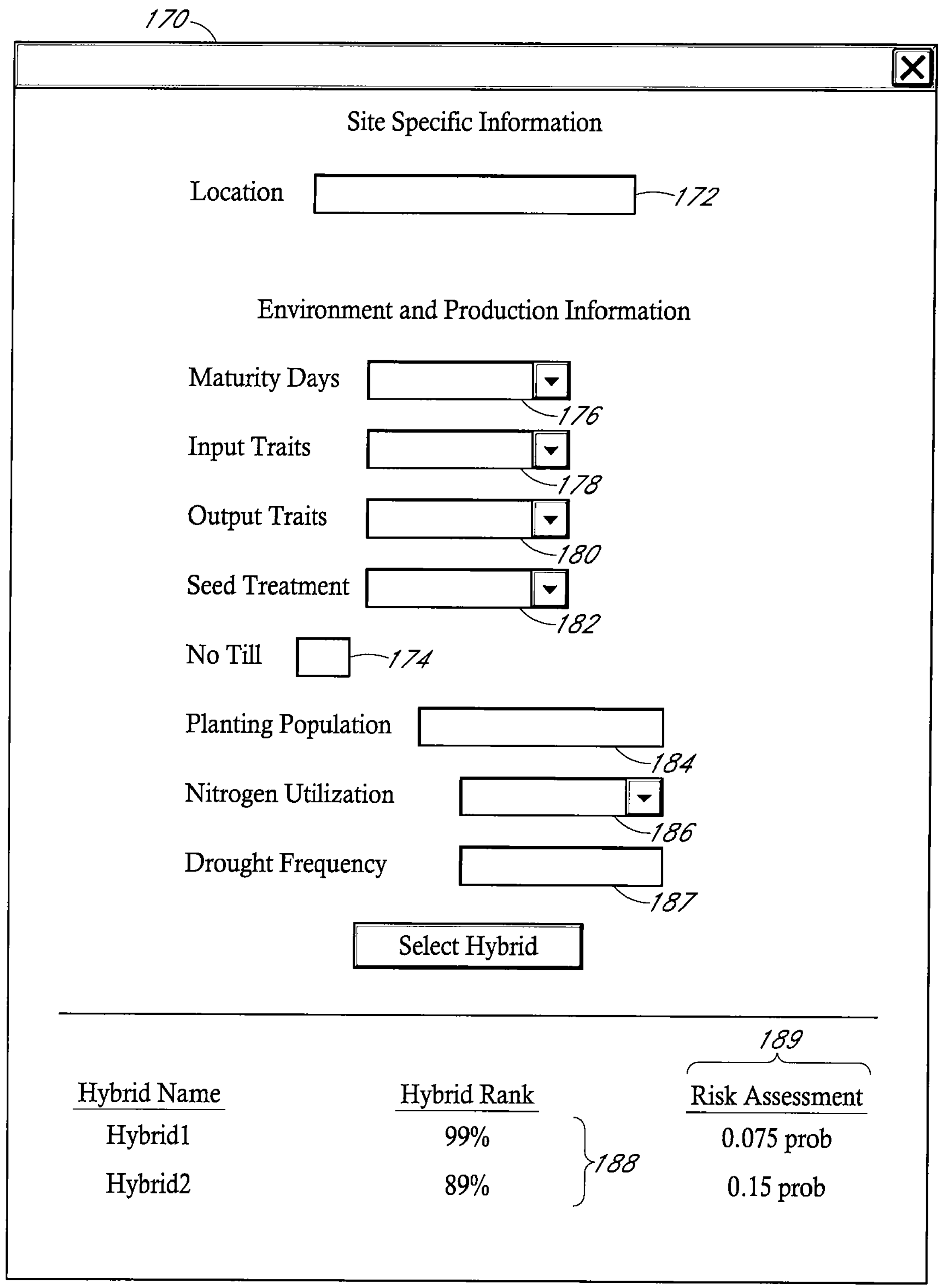

170
Site Specific Information
Location
172
Environment and Production Information
Maturity Days
176
Input Traits
178
Output Traits
180
Seed Treatment
182
No Till
174
Planting Population
184
Nitrogen Utilization
186
Drought Frequency
187
Select Hybrid
189
Hybrid Name
Hybrid Rank
Risk Assessment
Hybrid1
99%
0.075 prob
Hybrid2
89%
0.15 prob
188

FIG. 12

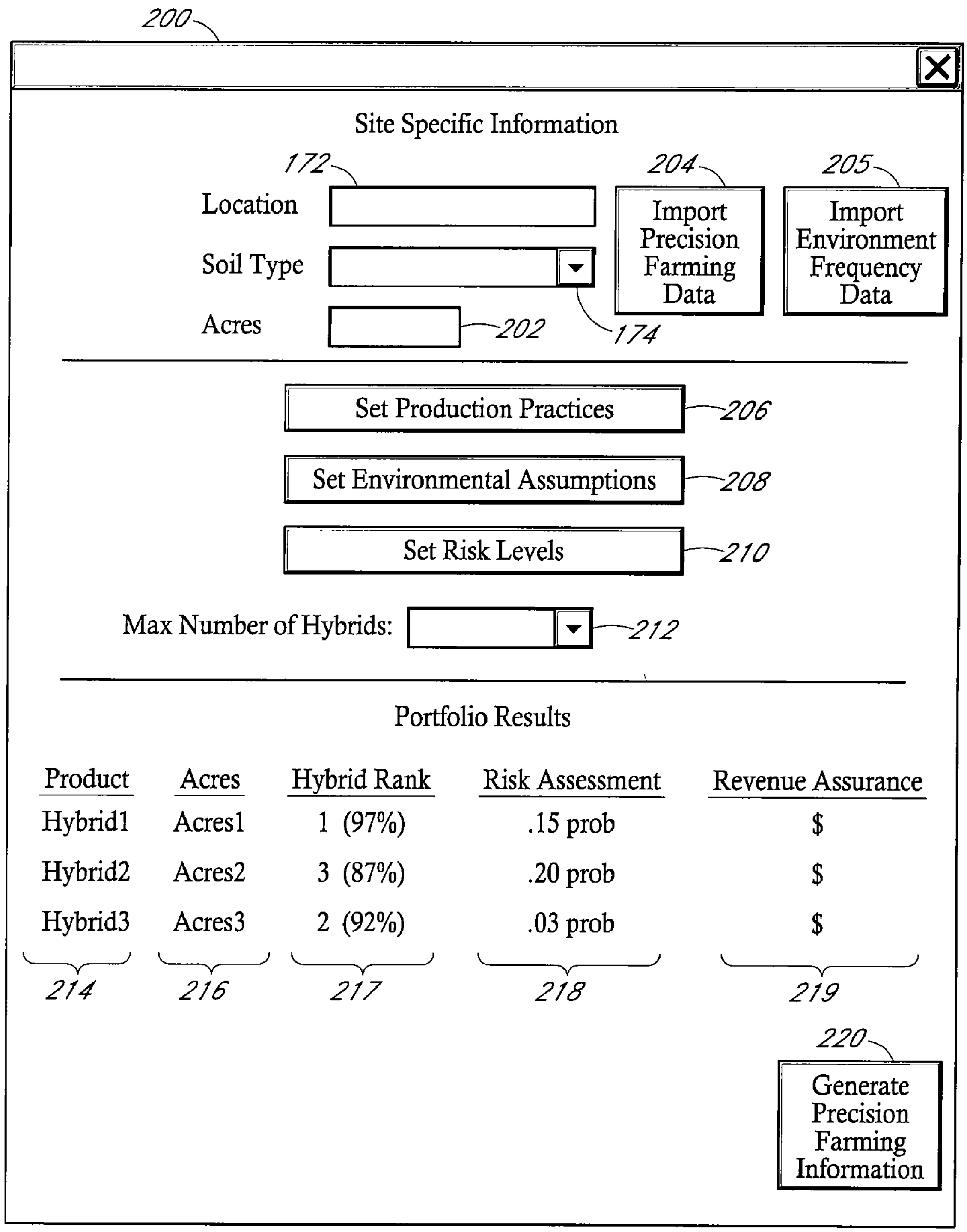

200
Site Specific Information
172
Location
Soil Type
Acres
202
174
204
Import Precision Farming Data
205
Import Environment Frequency Data
Set Production Practices
206
Set Environmental Assumptions
208
Set Risk Levels
210
Max Number of Hybrids:
212
Portfolio Results
Product
Acres
Hybrid Rank
Risk Assessment
Revenue Assurance
Hybrid1
Acres1
1 (97%)
.15 prob
$
Hybrid2
Acres2
3 (87%)
.20 prob
$
Hybrid3
Acres3
2 (92%)
.03 prob
$
214
216
217
218
219
220
Generate Precision Farming Information

FIG. 13

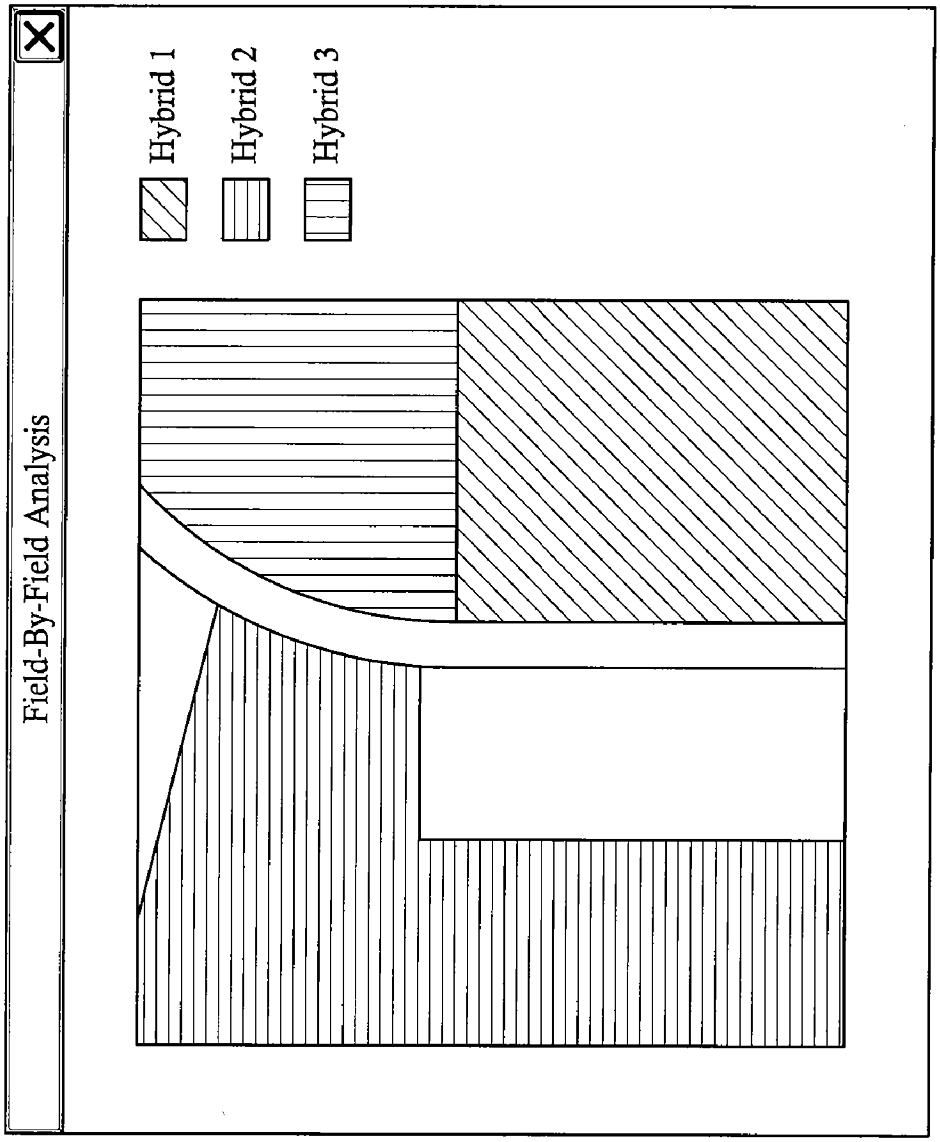


FIG. 14

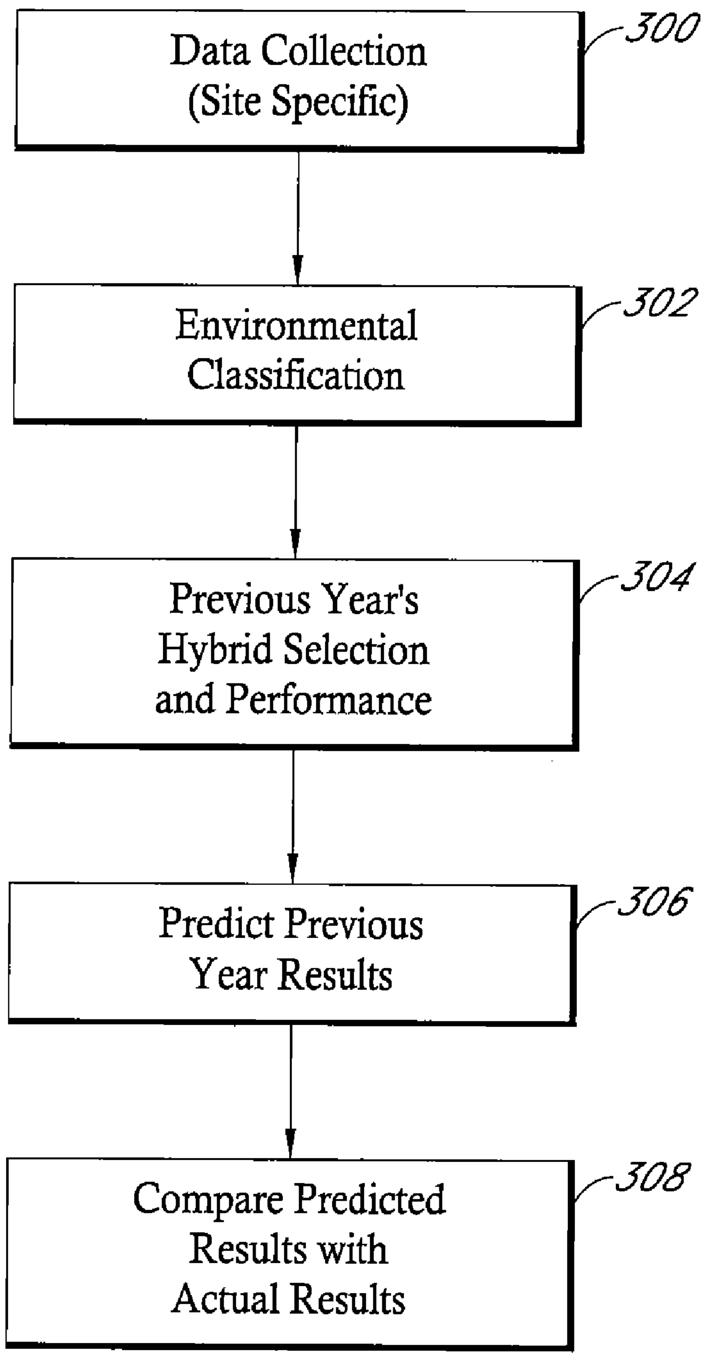

Data Collection
(Site Specific)
300
Environmental
Classification
302
Previous Year's
Hybrid Selection
and Performance
304
Predict Previous
Year Results
306
Compare Predicted
Results with
Actual Results
308

FIG. 15

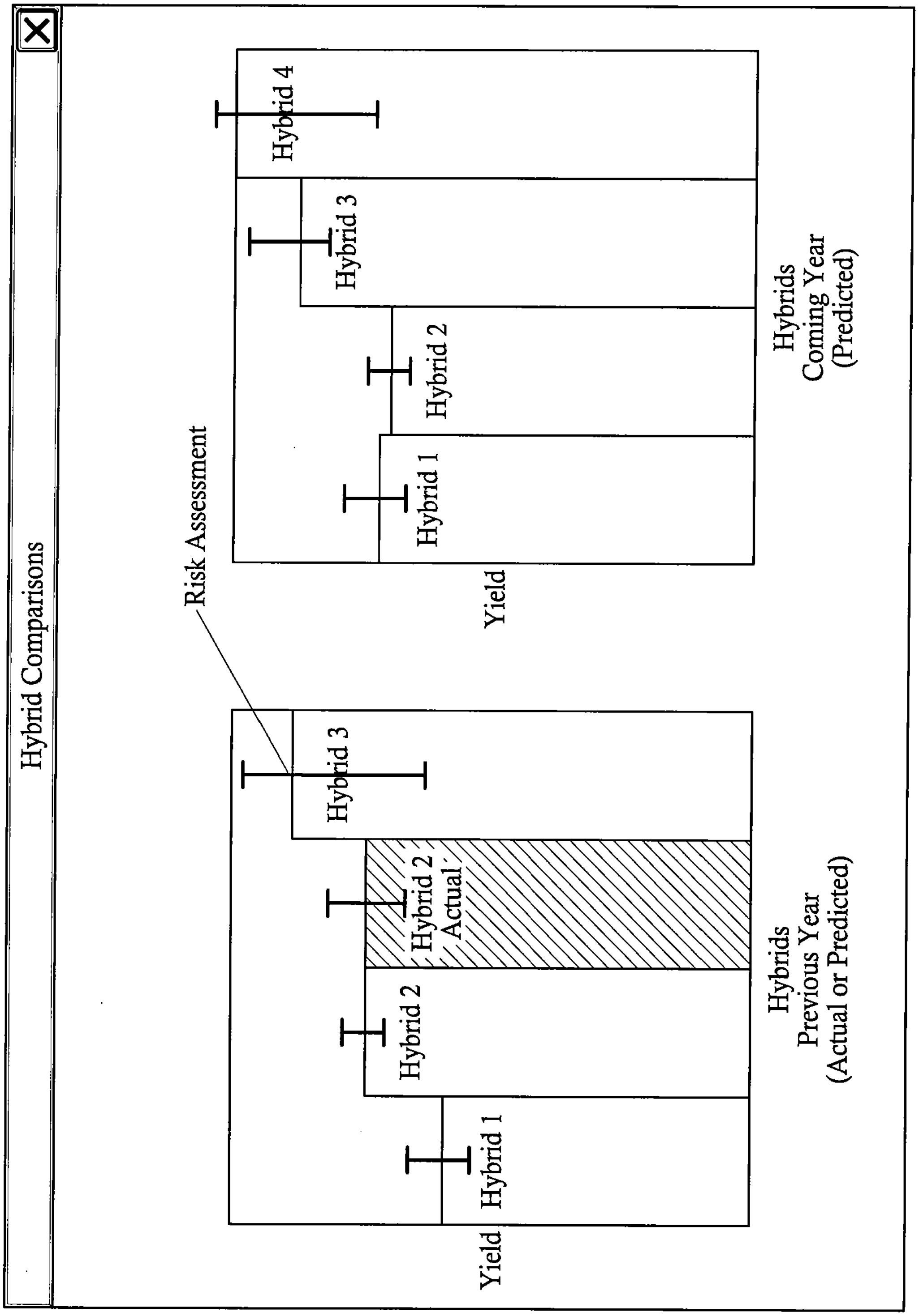

Hybrid Comparisons
Risk Assessment
Yield
Hybrid 1
Hybrid 2
Hybrid 2
Actual
Hybrid 3
Hybrids
Previous Year
(Actual or Predicted)
Yield
Hybrid 1
Hybrid 2
Hybrid 3
Hybrid 4
Hybrids
Coming Year
(Predicted)

FIG. 16

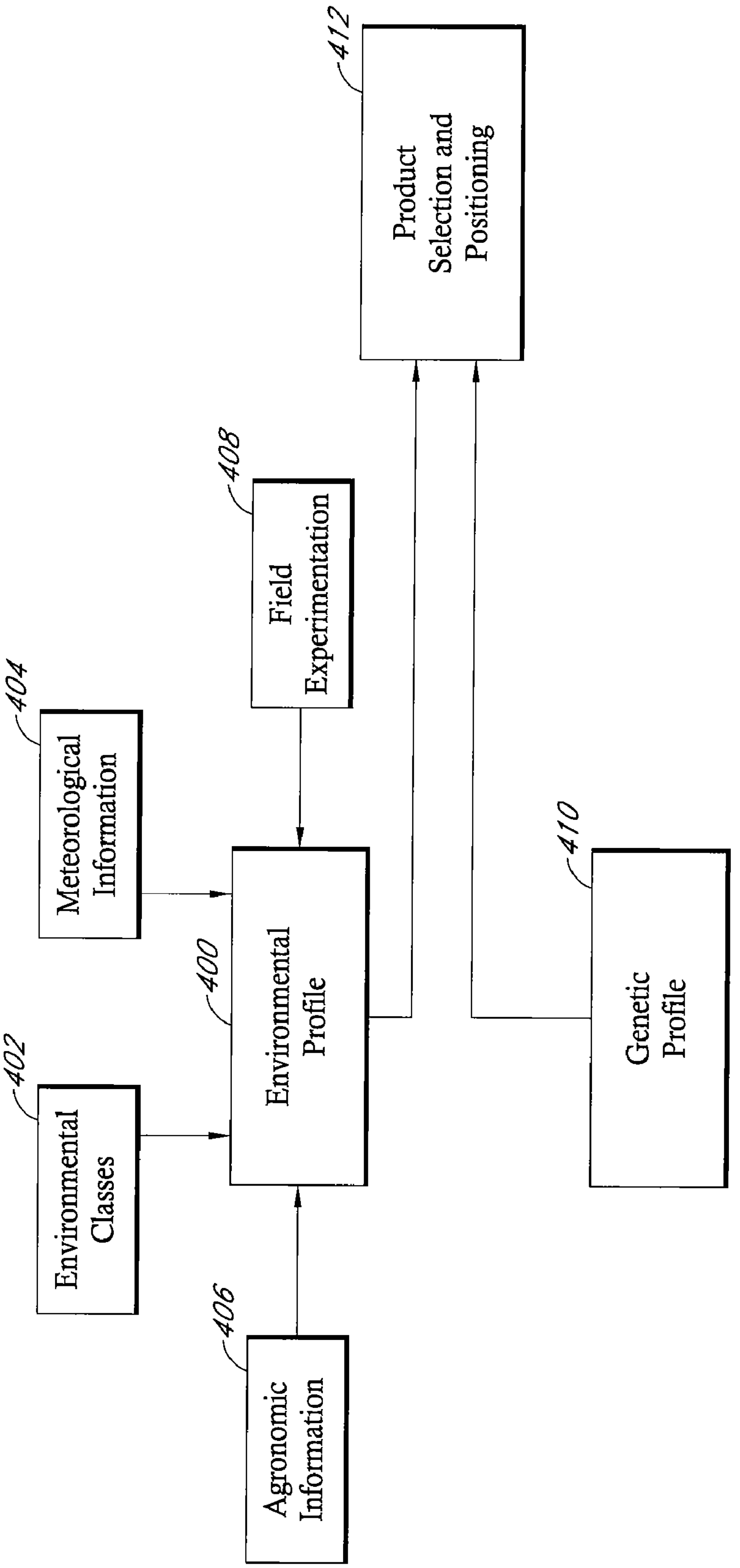

Product Selection and Positioning
412
Field Experimentation
408
Meteorological Information
404
Environmental Profile
400
Environmental Classes
402
Agronomic Information
406
Genetic Profile
410

FIG. 17

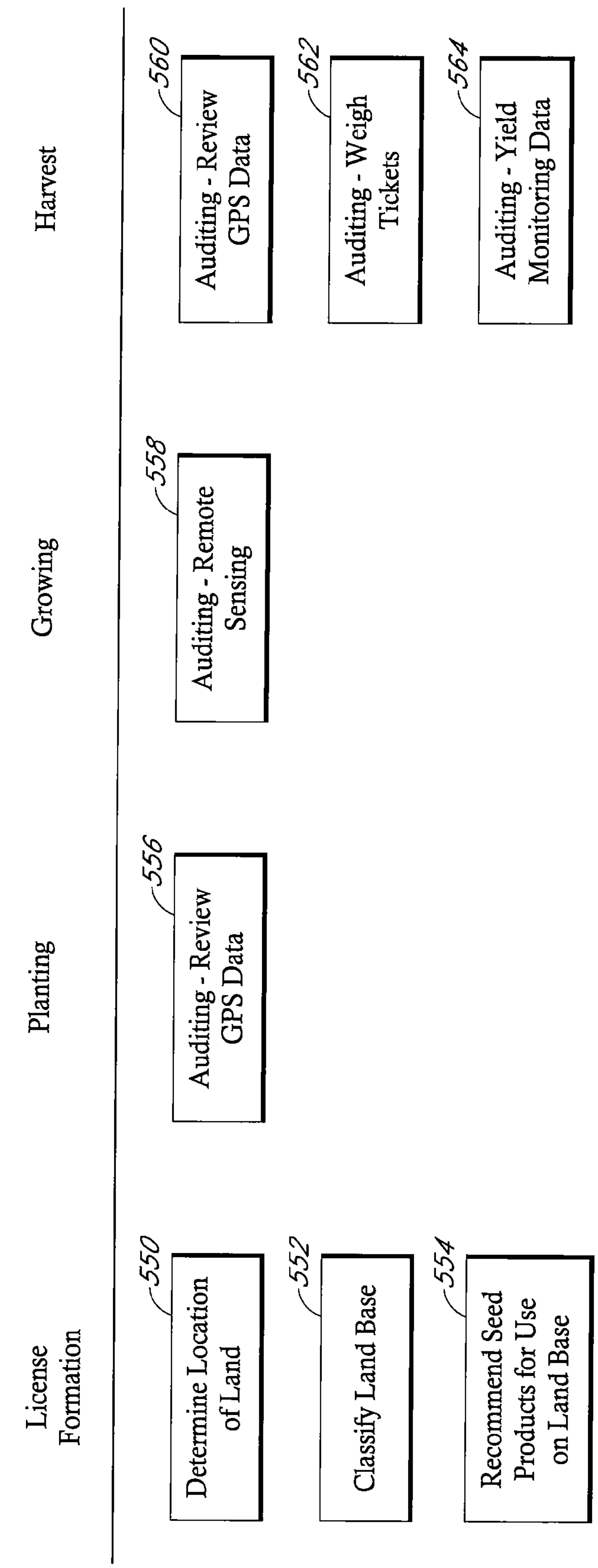

License Formation
Planting
Growing
Harvest
550
Determine Location of Land
552
Classify Land Base
554
Recommend Seed Products for Use on Land Base
556
Auditing - Review GPS Data
558
Auditing - Remote Sensing
560
Auditing - Review GPS Data
562
Auditing - Weigh Tickets
564
Auditing - Yield Monitoring Data

FIG. 18

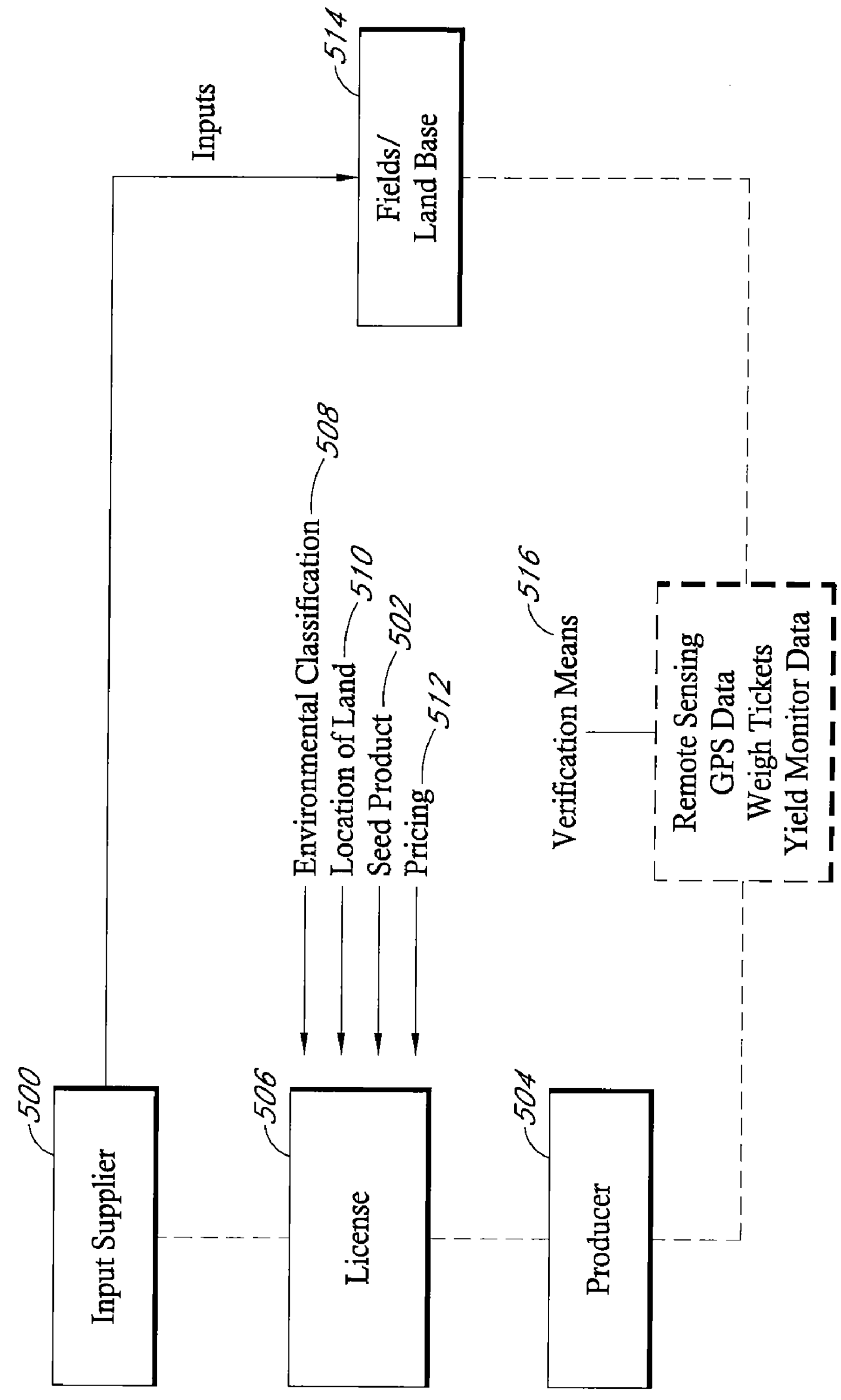

Input Supplier
500
License
506
Producer
504
Inputs
Fields/
Land Base
514
Environmental Classification
508
Location of Land
510
Seed Product
502
Pricing
512
Verification Means
516
Remote Sensing
GPS Data
Weigh Tickets
Yield Monitor Data

FIG. 19

METHOD AND SYSTEM FOR LICENSING BY LOCATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. § 119 of a provisional application Ser. No. 60/689,716 filed Jun. 10, 2005, which application is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention provides for computer-implemented methods and related methods which apply a performance-based pricing model to the selling of seed products

[0003] The productivity of ground can vary significantly, from fertile ground with a desirable actual production history (APH) to lower quality ground with a poor performance history. Producers planting on less productive ground have a greater need to keep the cost of agricultural inputs, such as seed, as low as possible. Thus, a producer may be weary of genetically superior seed products which, even though would increase performance over alternatives, have an associated premium price. Where a producer is using less productive ground they simply may not be able to justify the premium price.

[0004] What is needed therefore is a method for licensing and/or selling seed to the producer where the price of the seed is based at least in part on the location and quality of the land on which the seed is to be planted. Further needed is a method of auditing the performance of the seed product on the land base during and after planting of the seed product.

SUMMARY OF THE INVENTION

[0005] Therefore it is a primary object, feature, or advantage of the present invention to improve over the state of the art.

[0006] Another object, feature or advantage of the present invention is to provide a method to license and/or sell seed to producers where the price of the seed is based at least in part on the quality of the land on which the seed is to be planted.

[0007] Yet another object, feature or advantage of the present invention is to provide a method to license and/or sell seed to producers where the price of the seed is based at least in part on the expected performance of the seed product.

[0008] A further objective, feature, or advantage of the present invention is to assist producers in selecting the best seed product for a particular location.

[0009] A still further objective, feature, or advantage of the present invention is to verify that seed is used in the location where it is reported to be used.

[0010] Another objective, feature, or advantage of the present invention is to audit the performance of the seed product during and after the seed product has been planted on the land base.

[0011] Yet another object, feature, or advantage of the present invention is to provide additional incentives to producers for selecting seeds products for a particular location with a greater likelihood of performance.

[0012] One or more of these and/or other objects, features, or advantages of the present invention will become apparent from the specification and claims that follow.

[0013] According to one aspect of the present invention a method for selling seed products for planting by a crop producer is provided. The method includes characterizing the land base where the seed will be planted, determining the type of seed to be planted, and pricing the seed product. The seed product is priced based at least in part on performance or expected performance of the seed product within the land base. To assist in determining expected performance, the land may be characterized using environment classification systems.

[0014] A recommendation or requirement for the type of seed used may be provided. The type of seed planted at the land base may be determined at least partially based on performance of the seed product in an environmental classification associated with the land. The seed product may be recommended at least partially based on expected genotype-by-environment interactions between the seed product and the land base.

[0015] According to another aspect of the present invention, a method of selling seed products to a producer ties compensation for the seed products to the quality of the land base of the producer. The method includes evaluating the land base of the producer to determine a quality of the land base. In addition to the quality of the land base, determining the compensation for the seed product may, without limitation, be at least partially based on the expected performance of the seed product within the land base and/or the actual performance of the seed product within the land base.

[0016] Evaluation of the land base may be performed by using an environmental classification of the land base. The environmental classification may be selected from a set of environmental classes. For example, the environmental classes can be a temperate class, a temperate dry class, a temperate humid class, a high latitude class, s subtropical class or biotic classification.

[0017] The performance of the at least one seed product within the land base may also be audited. Particularly, where pricing is based on actual performance, there is a need to audit performance to ensure that a fair price is arrived upon. The auditing may be done by several different means, including, but not limited to, auditing GPS data (including, but not limited to, GPS data associated with planting and/or harvesting seed product in the land base) associated with crop production in the land base, reviewing weigh tickets and/or yield monitoring data for crops produced from the land base, and/or remote sensing of the land base.

BRIEF DESCRIPTION OF THE FIGURES

[0018] **FIG. 1** is a flow diagram illustrating one process for determining genotype-by-environment interactions and using that information in categorizing land bases into different environmental classifications.

[0019] **FIG. 2A** to **FIG. 2C** provide an example of genotype by environment interactions and cross-over interactions between two different varieties in four different environmental classes.

[0020] **FIG. 3** illustrates environment-standardized GGE biplot of grain yield of 18 maize hybrids (H1-H18) grown in 266 environments over three years stratified by state.

[0021] **FIG. 4** illustrates environment-standardized GGE biplot of grain yield of 18 maize hybrids (H1-H18) grown in 266 environments over three years stratified by environmental class.

[0022] **FIG. 5** illustrates one possible schematic for categorizing different land bases into environmental classifications based on temperatures, solar radiation, and length of photoperiod.

[0023] **FIG. 6** is a bar graph representation of the frequency of various environmental classes among target population of environments (TPEs) or multi-environment trials (METs).

[0024] **FIG. 7** illustrates potential categories of environmental classes identified throughout the United States in 1988 and their locations; these include temperate, temperate dry, temperate humid, high latitude, and subtropical classes.

[0025] **FIG. 8** is a flow diagram illustrating information flow from an environmental profile and a producer profile to providing recommendations to a producer according to one embodiment of the present invention.

[0026] **FIG. 9** is block diagram illustrating a system for determining product recommendations according to one embodiment of the present invention.

[0027] **FIG. 10** is a screen display according to one embodiment of the present invention.

[0028] **FIG. 11** is a screen display showing a product portfolio according to one embodiment of the present invention.

[0029] **FIG. 12** is a screen display for one embodiment of an application of the present invention.

[0030] **FIG. 13** is a screen display for one embodiment of an application of the present invention.

[0031] **FIG. 14** is a screen display for one embodiment of the present invention showing field-by-field product recommendations.

[0032] **FIG. 15** is a flow diagram for one embodiment of a sales tool for demonstrating the value of environmental classification in describing relative performance.

[0033] **FIG. 16** is a screen display illustrating one example of output from a sales tool of the present invention for demonstrating the value of environmental classification in describing relative performance.

[0034] **FIG. 17** is a flow diagram showing information flow in a product selection and positioning application of the present invention.

[0035] **FIG. 18** is a block diagram illustrating formation of a license for planting seed product in a particular location and auditing the planting of the seed product in the location.

[0036] **FIG. 19** is a flow diagram illustrating information flow in formation of a license for planting seed product in a particular location and auditing the planting of the seed product in the location.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0037] The present invention provides for computer-implemented methods and related methods which tie compensation received for seed products to actual performance of the seed product within a particular field (or other land base) or to expected performance of the seed product within a particular field or other land base. The present invention may use environmental classification and/or an understanding of genotype-by-environment interactions to evaluate the land base and/or determine the compensation for the seed product. Thus, seed can be recommended to, sold to, and/or provided to a producer where the compensation for or price of the seed is determined based upon performance-expected performance or actual performance.

[0038] Where the performance is actual performance, it may be audited in order to, among other things, verify the use of the seed within the particular land base. In other words, if compensation is tied to performance of a particular field, some form of auditing is needed to verify that the seed is actually planted in the field which it was purchased for. This type of verification is desirable both when the pricing is based on actual performance and expected performance. A second level type of verification is used to verify the performance of the crop. Verifying the use of the seed within the particular land base can be performed by evaluating various data typically associated with crop planting, production and harvesting.

[0039] Where the compensation provided to an agricultural input supplier (such as a reed company) is tied to performance, the agricultural input supplier has an added incentive for the producer to be successful. One way in which the agricultural input supplier can potentially increase the likelihood of the producer being successful is by making appropriate recommendations of the agricultural inputs to be used, particularly by where the agricultural input supplier is in a better position than the producer to make such a decision. A producer will understand that the agricultural input supplier is making recommendations to increase performance and may therefore be more willing to that and reply upon the recommendation. In addition, the agricultural input supplier may require the producer to take their recommendations in order to reduce the risk created for it.

[0040] One method to tie compensation received for seed products to an evaluation of the land base on which the seed products are or will be planted uses knowledge of genotype-by-environment interactions to assist a producer or other customer in selecting seed products to plant in one or more fields. A "genotype" is generally defined as a cultivar, genetically homogenous (lines, clones), a hybrid of two or more parents, or heterogeneous (open-pollinated populations). An "environment" is generally defined as a set of conditions, such as climatic conditions, soil conditions, biotic factors (such as, without limitation, pests and diseases) and/or other conditions that impact genotype productivity. "Management" as used in this context generally refers to production management decisions, such as, but not limited to crop production practices. In addition, the present invention allows for the use of environmental characterizations to assist in describing genotype-by-environment interactions. It is to be understood that the term "genotype-by-environment" (G×E) is to encompass what is sometimes known or referred to as "genotype-by-environment-by management" (G×E×M) as the environment associated with a plant may include management practices which affect the environment (for example, irrigation may be considered a management practice, but use of irrigation affects the growing environment).

[0041] Following, is an exemplary description regarding the use of G×E interactions and environmental classification. Next, the determination of compensation in exchange for seed products where the compensation is at least partially based on evaluating the land is discussed. Then, the verification of the performance of the seed and other means by which risk can be minimized is discussed.

G×E and Environmental Classification

[0042] Genetic manipulation alone does not ensure that a plant will perform well in a specific environment or for that matter a wide range of environments year after year. In other words, there is no one genotype that is likely to performance best in all environments or under all management practices. The performance or phenotype results from an interaction between the plant's genotype and the environment and the management practices used.

[0043] It is to be understood that there are some inherent difficulties in understanding such interactions. An environment at a given location changes over the years making multi-environment trials (METs) performed in the same location limited as to inferences about future crop performance. Furthermore, inferences about a crop's future performance in different locations depend on whether the target population of environments (TPEs) is well sampled since the environment varies between different locations in one year.

[0044] To assist in analyzing such interactions, the present invention preferably uses environmental classification techniques. The environmental classification techniques are used, preferably with a large set of data to relate performance of different genotypes to different environments. Environmental classification is then used when selecting the best seed products for a particular land base. Thus, for example, a producer can use environmental classification to select the best seed products for their land base based on the expected environmental conditions. Alternatively, the producer may diversify and select a combination of seed products based on a range of expected environmental conditions to thereby manage risks associated with environmental variability. Of course, environmental classification can be used by not just producers but others having interest in agricultural production.

[0045] **FIG. 1** provides an overview of one G×E paradigm where G×E knowledge **12** is used in planning and positioning **18**. G×E knowledge **12** can be applied to crop modeling **14**. Crop modeling **14** and G×E knowledge **12** may either alone or together be used to classify environments. The G×E knowledge **12** and classified environments may be used in facilitating the positioning and/or planning **18** strategies, such as characterization of products, resource efficiency, risk management, product positions, and product selection.

[0046] Subsequent to positioning and planning, the producer will grow the selected products **26** and measure the performance results **24**. The producer may also collect environmental and physiological landmark data **28** and in conjunction with performance results **24** use it in analysis **20**. Analysis of environmental and physiological landmark data **28** and performance results **24** may undergo analysis **20** using G×E analysis tools or period-of-years database **22**.

Building an Environmental Classification System

[0047] The effectiveness of a product evaluation system for genotype performance largely depends on the genetic correlation between multi-environment trials (MET) and the target population of environments (TPE) (Comstock, R. E. 1977. 'Proceedings of the International Conference on Quantitative Genetics, Aug. 16-21, 1976' pp. 705-18. Iowa State University Press. Ames, USA.). For example, previous characterizations of maize environments relied mainly on climatic and soil data (e.g. Hartkamp, A. D., J. W. White, A. Rodriguez Aguilar, M. Bänziger, G. Srinivasan, G. Granados, and J. Crossa. 2000. Maize Production Environments Revisited: A GIS-based Approach. Mexico, D.F.CIMMYT.; Pollak, L. M., and J. D. Corbett. 1993. Agron. J. 85:1133-1139; Runge, E. C. A. 1968. Agron. J. 60:503-507.). While useful to describe environmental variables affecting crop productivity, these efforts did not quantify the impact of these variables on the genetic correlations among testing sites. Consequently, plant breeders have more extensively used characterizations of environments based on similarity of product discrimination in product evaluation trials (e.g. Cooper, M., D. E. Byth, and I. H. DeLacy. 1993. Field Crops Res. 35:63-74.). However, these efforts frequently fail to provide a long-term assessment of the target population of environments (TPE), mainly due to the cost and impracticality of collecting empirical performance data for widespread and long-term studies.

[0048] The present invention provides a modern approach of product evaluation where a TPE is described. The description of a TPE includes classifying the land base into an environmental class and assessing the frequency of occurrence of the range of environments experienced at a given location. The present inventors contemplate that areas of adaption (AOA) could also be evaluated. As used herein AOA refers to a location with the environmental conditions that would be well suited for a crop or specific genotype. Area of adaption is based on a number of factors, including, but not limited to, days to maturity, insect resistance, disease resistance, and drought resistance. Area of adaptability does not indicate that the crop will grow in every location or every growing season within the area of adaption or that it will not grow outside the area. Rather it defines a generally higher probability of success for a crop or genotype within as opposed to outside that area of adaptation.

[0049] The environmental information collected may be used to develop an environmental database for research locations. Initially, multiple environment trials are performed by planting different genotypes available from a variety of sources, e.g. germplasm, inbreds, hybrids, varieties in multiple environments. These trials aid the determination of whether the TPEs are homogenous or should be categorized into different environmental classifications. The performance data of these genotypes and environmental and/or physiological landmark data from the MET are collected and entered into a data set. For example, performance data collected for a genotype of corn may include any of the following: yield, grain moisture, stalk lodging, stand establishment, emergence, midsilk, test weight, protein, oil, and starch. Yield refers to bushels of grain per acre. Grain moisture refers to a moisture determination made from each plot at harvest time, using an instrument such as an electrical conductance moisture meter. Stalk lodging refers to the determination of the number of broken stalks in each plot prior to harvest. Stand establishment refers to the differences between the desired planting rate for each hybrid and the final stand. Emergence refers to an emergence count made on each plot after plant emergence where emergence percentage may be computed based on the number of plants and the number of kernels planted. The mid silk date is the Julian day of the year in which 50% of the plants show silks at one site in a region. The test weights are typically reported as pounds per bushel on grain samples at field moisture. Protein, oil and starch are typically reported as a percent protein, oil, and starch content at a designated percent grain moisture on dried samples using standard methods, for example, a near infrared transmittance whole grain analyzer.

[0050] One skilled in the art would be familiar with performance data collected for other crops, for example, soybeans, wheat, sunflowers, canola, rice and cotton. Performance data for soybeans include, without limitation, relative maturity, plant height, lodging score, seed size, protein and oil percentage, *Phytophthora* resistance genes, *Phytophthora* partial resistance, *Sclerotinia* rating, and yield. Relative maturity refers to a determination that is designed to account for factors, such as soybean variety, planting date, weather, latitude and disease that affect maturity date and number of days from planting to maturity. Plant height refers to a determination of the soybean plant's height, usually determined prior to harvest. Lodging, traditionally, the vertical orientation of the plant, i.e. the degree to which the plant is erect. The lodging of a soybean plant is traditionally rated by researchers using a scale of 1 to 9 as follows: 1.0=almost all plants erect, 3.0=either all plants leaning slightly, or a few plants down, 5.0=either all plants leaning moderately (45O angle), or 25-50% down, 7.0=either all plants leaning considerably, or 50-80% down, 9.0=all plants prostrate. The seed size of a soybean plant typically refers to thousands of seeds per pound. Protein and oil percentage analysis may be determined using near infrared transmittance technology and reported at 13% moisture. Phytophthora resistance genes may be determined using a hypocotyl inoculation test with several races of Phytophthora to determine the presence or absence of a particular Rps gene in a soybean plant. Soybeans may also be evaluated for *phytophthora* partial resistance using a ratings system, where ratings of 3.0 to 3.9 are considered high levels of partial resistance, ratings of 4.0 to 5.9 are considered moderate, ratings over 6.0 indicate very little partial resistance or protection against *Phytophthora*. Soybeans may also be evaluated for partial resistance to *Sclerotinia*. Yield refers to bushels per acre at 13 percent moisture.

[0051] Typical performance data for wheat includes, without limitation, test weight, protein percent, seed size, percent lodging, plant height, heading date, powdery mildew, leaf blotch complex (LBC), *Fusarium* head scab (FHS), flour yield, and flour softness. Test weight refers to a determination of pounds/bushell using harvest grain moisture. Seed size refers to thousands of harvested seeds per pound. Percent lodging as described previously refers to a rating system used to estimate the percent of plants that are not erect or lean more than 45 degrees from vertical. Plant height refers to the distance from the soil surface to the top of the heads. Heading date refers to the average calendar day of the year on which 50 percent of the heads are completely emerged. Wheat infected with powdery mildew (PM) may be determined using a scale system where each plot is rated based on a 0 to 10 scale where: 0=0 to trace % leaf area covered; 1=leaf 4 with trace—50%; 2=leaf 3 with 1-5%; 3=leaf 3 with 5-15%; 4=leaf 3 with >15%; 5=leaf 2 with 1-5%; 6=leaf 2 with 5-15%; 7=leaf 2 with >15%; 8=leaf 1 with 1-5%; 9=leaf 1 with 5-15%; and 10=leaf 1 with >15% leaf area covered (leaf 1=flag leaf). This scale takes into account the percentage leaf area affected and the progress of the disease upward on the plants. Leaf blotch complex (LBC) caused by *Stagonospora nodorum, Pyrenophora triticirepentis* and *Bipolaris sorokiniana* for example may be determined when most varieties are in the soft dough growth stage and rated based on the percentage of flag leaf area covered by leaf blotches. *Fusarium* head scab (FHS) caused by *Fusarium graminearum* for example may be determined when plants are in the late milk to soft dough growth stage and each plot is rated based on a disease severity estimate as the average percentage of spikelets affected per head. Flour yield refers to the percent flour yield from milled whole grain. Flour softness refers to the percent of fine-granular milled flour. Values higher than approximately 50 indicate kernel textures that are appropriate for soft wheat. Generally, high values are more desirable for milling and baking.

[0052] Typical performance data for sunflower includes, without limitation, resistance to aphids, neck breakage, brittle snap, stalk breakage, resistance to downy mildew (*Plasmopara halstedii*), height of the head at harvest, seed moisture, head shape, hullability, resistance to the sunflower midge, *Contarinia schulzi*, percentage of oil content, seed size, yield, seedling vigor, and test weight. Resistance to aphids refers to a visual ratings system indicating resistance to aphids based on a scale of 1-9 where higher scores indicate higher levels of resistance. Neck breakage refers a visual ratings system indicating the level of neck breakage, typically on a scale from 1 to 9 where the higher the score signifies that less breakage occurs. Brittle snap refers to a visual rating system indicating the amount of brittle snap (stalk breakage) that typically occurs in the early season due to high winds. The ratings system is based on a scale, usually ranging from 1-9, with a higher score denoting the occurrence of less breakage. A sunflower's resistance to Downy Mildew (*Plasmopara halstedii*) may be determined using a visual ratings scaled system with 9 being the highest and 1 the lowest. A higher score indicates greater resistance. Height of the head at harvest refers to the height of the head at harvest, measured in decimeters. Seed moisture refers to a determination of seed moisture taken at harvest time, usually measured as a percentage of moisture to seed weight. Head shape of a sunflower is measured visually using a scale system where each plot is rated based on a 1 to 9 scale where: 1=closed "midge" ball; 2=trumpet; 3=clam; 4=concave; 5=cone; 6=reflex; 7=distorted; 8=convex; 9=flat. Hullability refers to the ability of a hulling machine to remove seed hulls from the kernel, typically measured on a 1-9 scale where a higher score reflects better hullability. Resistance to the sunflower midge, *Contarinia schulzi*, is determined based on head deformation which is rated on a 1-9 scale where: 9=no head deformation (fully resistant), 5=moderate head deformation, 1=severe head deformation (fully susceptible). The percentage of oil content from the harvested grain is measured and adjusted to a 10% moisture level. The oil content of a sunflower seed may be measured for various components, including palmitic acid, stearic acid, oleic acid, and linoleic acid, using a gas chromatograph. Seed size refers to the percentage of grain that passes over a certain size screen, usually "size 13." Seedling vigor refers to the early growth of a seedling and is often times measured via a visual ratings system, from 1-9, with higher scores indicate more seedling vigor. Yield is measured as quintals per hectare, while test weight of seed is measured as kilograms per hectoliter.

[0053] Typical performance data for canola includes, without limitation, yield, oil content, beginning bloom date, maturity date, plant height, lodging, seed shatter, winter survival, and disease resistance. Yield refers to pounds per acre at 8.5% moisture. Oil content is a determination of the typical percentage by weight oil present in the mature whole dried seeds. Beginning bloom date refers to the date at which at least one flower is on the plant. If a flower is showing on half the plants, then canola field is in 50% bloom. Maturity date refers to the number of days observed from planting to maturity, with maturity referring to the plant stage when pods with seed color change, occurring from green to brown or black, on the bottom third of the pod bearing area of the main stem. Plant height refers to the overall plant height at the end of flowering. The concept of measuring lodging using a scale of 1 (weak) to 9 (strong) is as previously described. Seed shatter refers to a resistance to silique shattering at canola seed maturity and is expressed on a scale of 1 (poor) to 9 (excellent). Winter survival refers to the ability to withstand winter temperatures at a typical growing area. Winter survival is evaluated and is expressed on a scale of 1 to 5, with 1 being poor and 5 being excellent. Disease resistance is evaluated and expressed on a scale of 0 to 5 where: 0=highly resistant, 5=highly susceptible. The Western Canadian Canola/Rapeseed Recommending Committee (WCC/RRC) blackleg classification is based on percent severity index described as follows: 0-30%=Resistant, 30%-50%=Moderately Resistant, 50%-70%=Moderately Susceptible, 70%-90%=Susceptible, and >90%=Highly susceptible.

[0054] Typical performance data for cotton includes, without limitation, yield, turnout, micronaire, length, fiber strength of cotton and color grade. Yield is measured as pounds per acre. Turnout refers to lint and seed turnout which is calculated as the percentage of lint and seed on a weight basis as a result of ginning the sub sample from each treatment. Micronaire refers to fiber fineness and maturity and are measured using air flow instrument tests in terms of micronaire readings in accordance with established procedures. Fiber length is reported in 1/32 of an inch or decimal equivalents. Fiber strength is measured in grams per tex and represents the force in grams to break a bundle of fibers one tex unit in size. Color grade for cotton takes into consideration the color, fiber color and whiteness of cotton leaves. Color grade may be determined using a two digit scale. The two digit number is an indication of the fiber color and whiteness (i.e. 13, 51, or 84). The first digit can range from 1 to 8 representing overall color with 1 being the best color and 8 representing below grade colors. The second digit represent a fiber whiteness score. This number ranges from 1 to 5, with 1 representing good white color and 5 representing yellow stained. The second number in the overall color grade represents the leaf score and represents leaf content in the sample.

[0055] Typical performance data for rice includes, without limitation, yield, straw strength, 50% Heading, plant height, and total milling, and total milling. Yield is measured as bushels per acre at 12% moisture. Straw Strength refers to lodging resistance at maturity and is measured using a numerical rating from 1 to 9 where 1=Strong (no lodging); 3=Moderately strong (most plants leaning but no lodging); 5=Intermediate (most plants moderately lodged); 7=Weak (most plants nearly flat); and 9=Very weak (all plants flat). 50% heading refers to the number of days from emergence until 50% of the panicles are visibly emerged from the boot. Plant height is the average distance from the soil surface to the tip of erect panicle. Total milling refers to the total milled rice as a percentage of rough rice. Whole milling refers to rice grains of ¾ length or more expressed as a percentage of rough rice.

[0056] The environmental and physiological landmark data may be historical using historical meteorological information along with soils and other agronomic information or collected using National Oceanic and Atmospheric Association and/or other public or private sources of weather and soil data. Potential environmental and physiological landmark data that may be collected includes but is not limited to wind, drought, temperature, solar radiation, precipitation, soil type, soil pH, planting and harvesting dates, irrigation, tiled area, previous crop, fertilizer including nitrogen, phosphorous, and potassium levels, insecticide, herbicide, and biotic data, for example, insects and disease. The environmental and physiological landmark data may then be analyzed in light of genotype performance data to determine G×E interactions.

Models

[0057] Several models for determining G×E interactions exist. Base models group or classify the locations used to test the hybrids, include several variance components, and stratify the hybrids, for example, according to locations among station-year combinations, locations, or other chosen variances.

[0058] For example, as shown in Table 1, one base model Year Station (YS) groups the locations by year-stations where a year-station designates a unique site or location by year. Other variances include blocks within locations within year-stations, hybrids, hybrids by year-station divided by the sum of hybrids by locations within year station locations as well as a residual. The YS model is disadvantageous in that a given location's environment will vary over time so that the G×E information gleaned from the model may not be relevant for predicting hybrids that will perform well in the same location next year.

[0059] Another model for determining G×E interactions disclosed in Table 1, groups different sites by location. Other variances for the G×E model include blocks within locations, hybrids, hybrids by locations, as well as a residual. However, the G×E model is disadvantageous in that a genotype grown in locations with differing environmental conditions may have similar performance results, complicating the analysis of the specific environmental conditions that play a role in contributing to genotype performance and reducing the certainty of predicting product performance.

[0060] Unlike the previous models mentioned, the present inventors contemplate determining G×E interactions using a model referred to herein as Environmental Classification that groups locations by environmental classifications. Thus, variances for this model include locations within environmental classifications, blocks within locations within environmental classifications, hybrids, hybrids by environmental classifications divided by hybrids by locations within environmental classifications and a residual.

TABLE 1

Models for determining G × E interactions

Model	Year-Station	G × E	Environmental Classification
Variance for location	Location within year-station	Location	Location within environmental classification
Variance for location	blocks within locations within year-station	blocks within locations	blocks within locations within environmental classifications
Variance for hybrids	hybrids	hybrids	hybrids
Stratifications	hybrid by year-station/ hybrids by locations within locations	hybrid by locations	hybrid by environmental classifications/ hybrid by locations within environmental classifications

[0061] Burdon has shown that genetic correlation between G×E interactions can be estimated. (Burdon, R. D. 1977. Silvae Genet., 26: 168-175.). G×E analysis may be performed in numerous ways. G×E interactions may be analyzed qualitatively, e.g. phenotype plasticity, or quantitatively using, for example, an analysis of variance approach. (Schlichting, C. D. 1986. Annual Review of Ecology and Systematics 17: 667-693.). Statistical analysis of whether a G×E interaction is significant and whether environmental changes influence certain traits, such as yield performance, of the genotypes evaluated may be performed using any number of statistical methods including but not limited to, rank correlation, analysis of variances, and stability.

Rank Correlation

[0062] The most basic categorization of G×E interaction is to evaluate G×E interactions by performing a rank correlation according to standardized tests, for example, Spearman. The Spearman rank correlation may be performed to examine the relationships among genotypes in different environments, for example, crossover interactions that occur when two genotypes change in rank order of performance when evaluated in different environments. **FIG. 2** illustrates an example of G×E interactions and cross-over interactions (COI) between two different varieties, Var A and Var B, in four different environmental classes, Env 1, Env 2, Env 3 and Env 4. **FIG. 2A** shows that Var A and Var B out-perform each other in different environments indicating the occurrence of both G×E and COI. **FIG. 2B** shows that Var A performed better than Var B in each environment, indicating G×E interactions but no COI. In contrast, **FIG. 2C** shows that Var A and Var B each performed consistently with respect to each other in all four environments, indicating lack of G×E interactions.

Analysis of Variance (ANOVA)

[0063] Alternately, G×E interactions may be analyzed using an analysis of variance method (ANOVA) (Steel, R. G. D and J. H. Torrie. 1980. Principles and Procedures of Statistics, 2nd edition) over environments to determine the significance of genotypes, environments and G×E interactions. G×E interactions may also be analyzed using ASREML (Gilmour, A. R., Cullis, B. R., Welham, S. J. and Thompson, R. 2002 ASReml Reference Manual 2nd edition, Release 1.0 NSW Agriculture Biometrical Bulletin 3, NSW Agriculture, Locked Bag, Orange, NSW 2800, Australia.) for the computation of variance components, and the generation of GGE biplots (Cooper, M., and I. H. DeLacy. 1994. Theor. Appl. Genet. 88:561-572; Yan, W. and M. S. Kang. 2003. *GGE Biplot Analysis: A Graphical Tool for Breeders Geneticists, and Agronomists*. CRC Press. Boca Raton, Fla.). **FIG. 3** and **FIG. 4** illustrate environment-standardized GGE biplot of grain yield of 18 maize hybrids (H1-H18) grown in 266 environments over three years, stratified by state or by environmental class respectively.

Stability

[0064] Once certain genotypes are identified that perform well in a target environment they may be analyzed to determine which hybrids are more stable in yield or other metrics using various methods. One method uses a regression of genotypic performance on an environmental index. In general, the environmental index is the deviation of the mean phenotype at environment from the overall mean phenotype of all environments. Thus, the phenotype of an individual genotype with each environment is regressed on the environmental index, as described in Bernardo R. 2002. Quantitative Traits in Plants. Stemma Press, Woodbury, Minn. to generate a slope (b-value) for each genotype/cultivar evaluated. Other methods include the joint regression analysis method proposed by Perkins, J. M. and Jinks, J. L. 1968. Heredity. 23: 339-359, Finlay, K. W. and Wilkinson, G. N. 1963. Aust. J. Res. 14: 742-754 and Eberhart, S. A. and Russell, W. A. 1966. Crop Sci. 6:36-40 to calculate the regression coefficient (b), S.E. and variance due to deviation from regression (S2d) as a parameter of stability and adaptability. The model described by Eberhart and Russell has the following formula:

$$P_{ij}=\mu+g_i+b_it_j+\delta_{ij}+e_{ij}$$

[0065] where P_{ij} is the mean phenotype of genotype or cultivar i in location j, μ is the grand mean across the whole experiment for all genotypes and locations,

[0066] g_i is the effect of genotype i across all locations

[0067] b_i is the linear regression of P_{ij} on t_j,

[0068] t_j is the environmental index, that is the effect of environment j across all genotypes),

[0069] δ_{ij} is the deviation P_{ij} from the linear regression value for a given t_j and

[0070] e_{ij} is the within environment error.

Categorization of Land Bases into Environmental Classes

[0071] Using the information collected for or from G×E analysis, the land bases may be categorized into environmental classifications. **FIG. 5** illustrates one possible schematic for categorizing different land bases into environmental classifications. With reference to **FIG. 5**, one method of categorizing environmental classifications is illustrated as a flow chart. If all maximum temperatures are greater than 28° Celsius **42**, then the land base may be categorized as either Temperate Dry **54**, Temperate Humid **52**, Temperate **56**, or Subtropical **48**. If all maximum temperatures are greater to or equal to 30° Celsius and solar radiation is greater than 24 and 21 at a given crop development stage, e.g. v7-R1, R3-R6 **40**, then the land base is characterized as Temperate Dry **54**. If the maximum temperature is not greater than or equal to 30° Celsius and solar radiation is not greater than 24 at a given crop development stage, e.g. V7-R1 and 21 for R3-R6 respectively **40**, then the land base is characterized as Temperate **56**. However, if the maximum temperature is less than 30° Celsius and solar radiation is greater than 24 and 21 at a given crop development stage **50**, then the land base is characterized as Temperate Humid **52**. If the maximum temperature is not less than 30° Celsius and solar radiation is not greater than 24 and 21 at a given crop development stage **50**, then the land base is characterized as Temperate **56**. If all maximum temperatures **42** for the land base are less then 28° Celsius than the land base is characterized as High Latitude **44**. In contrast, if all maximum temperatures **42** for the land base are not less then 28° Celsius and the land base has a photoperiod less than 13.4 hours/day **46**, then the land base is Subtropical **48**.

[0072] Categorizing land bases into environmental classifications has several advantages. First, environmental classifications can bring an understanding of the various environments under which crops are produced. Second, occurrence probabilities for each environmental category can be assigned to each geographic location and the frequency of the classifications determined using routine methods. **FIG. 6** is a bar graph representation of the frequency of various environmental classes among TPEs or METs. The frequency for each environmental class, e.g. temperate, temperate dry, temperte humid, high latitude, and subtropical, is given as a percent of the total TPE or MET tested in given year or across years. **FIG. 7** illustrates potential categories of environmental classes identified throughout the United States in 1988 and their locations; these include temperate, temperate dry, temperate humid, high latitude, and subtropical classes. It will be apparent to one skilled in the art that other environmental classifications may added as identified or deemed relevant to G×E interactions for various crops.

[0073] Some of the environmental classification may be defined using general characteristics of climates. For example, temperate may be used to refer to regions in which the climate undergoes seasonal change in temperature and moisture; typically these regions lie between the Tropic of Capricorn and Antarctic circle in the Southern Hemisphere and between the Tropic of Capricorn and the Arctic circle in the Northern Hemisphere. Temperate humid may refer to regions in which the climate undergoes seasonal change in temperature and moisture and has more humidity than a temperate environment. High latitude as an environmental class may refer to regions that have a longer photoperiod than and is typically north of a particular latitude. A subtropical class may refer to regions enjoying four distinct seasons usually with hot tropical summers and non-tropical winters with a shorter photoperiod/day length; typically these regions lie between the ranges 23.5-40° N and 23.5-40° S latitude. The environmental classes may also be defined by biotic factors, such as diseases, insects, and/or characteristic of a plant. For example, an ECB class may refer to regions having European Corn Borers (ECB) or the suspected presence of ECB as evidenced by preflowering leaf feeding, tunneling in the plant's stalk, post flowering degree of stalk breakage and/or other evidence of feeding. The environmental class Brittle may be used to refers to regions where stalk breakage of corn occurs or is apt to occur near the time of pollination and is indicative of whether a hybrid or inbred would snap or break near the time of flowering under severe winds.

[0074] It is to be understood that the environmental classifications may be used and defined differently for different crops/genotypes and that these definitions may vary from year to year, even for the same crops or genotypes. For example, in 2000-2003, trials conducted studying G×E interactions among Comparative Relative Maturity (CRM) hybrids of CRM 103-113 in different environments identified seven different environmental classes—temperate, temperate dry, temperate humid, high latitude, subtropical, ECB, and brittle. For the study purposes, temperate was identified/defined as having a low level of abiotic stresses, a growing season adequate for CRM 103-113, and found to be frequent in Iowa and Illinois. Temperate dry was defined as temperate with some level of water and/or temperature stress and found to be frequent in Nebraska, Kansas, and South Dakota. Temperate Humid was defined as similar to the temperate environmental class but had a complex of biotic factors, such as leaf disease, that may differentially affect product performance. Temperate humid was also characterized as having a temperature and solar radiation lower than that identified in the temperate environmental class and found to be frequent in Indiana, Ohio, and Pennsylvania. The High Latitude environmental class was found to grow corn CRM 103 and earlier (growing hybrids) and experienced colder temperatures than the Temperate environmental class but with longer day-length. This environmental class was found to be frequent in Canada, North Dakota, Minnesota, Michigan, and Wisconsin. The fifth environmental class, Subtropical, was characterized as warm and humid with a short day-length and found frequently in the Deep South of the United States. Another environmental class identified was European Corn Borers (ECB) and defined as having *Bacillus thuringiensis* (Bt) hybrids that outyielded base genetics by at least 10%. The last environmental class Brittle defined areas with significant brittle damage with differential effect on products.

[0075] Once areas of land are categorized as environmental classes, these areas may be used in METs. Ultimately, the observed genotype performances in METs can be linked by the environmental class to the TPE. By evaluating product performance in a target environment, rather than merely performance differences in METs, genotype performance data from multiple test environments can be correlated to a target environment and used to predict product performance. This correlation between a genotype's performance and the target environment or environmental classification will lead to more precise product placement since the genotype performance is characterized within an environmental class in which it is adapted and most likely to experience after commercialization, consequently resulting in improved and more predictable product performance. The analysis of G×E interactions facilitates the selection and adoption of genotypes that have positive interactions with its location and its prevailing environmental conditions (exploitation of areas of specific adaption). G×E analysis also aids in the identification of genotypes with low frequency of poor yield or other performance issues in certain environments. Therefore, G×E analysis will help in understanding the type and size of G×E interactions expected in a given region. The present inventors contemplate that proper selection of hybrids for a particular land base will improve agricultural potential of certain geographic areas by maximizing the occurrence of crop performance through the use of the environmental classification. In addition, this approach allows the use of statistical and probability based analysis to quantify the risk of product success/failure according to the frequency of environment classes and the relative performance of genotypes within each environment class. This early identification and selection of hybrids would enable seed producers to start seed production and accelerate the development of hybrids in winter nurseries in warmer southern climates.

[0076] Moreover, environmental classification allows for the creation of an environmental profile for all or any part of the land base classified. Environmental classifications can be determined for each producer's land base. Similarly, the environmental performance profile of cultivars/hybrids can be determined through field experimentation or predicted using G×E analysis. In combining environmental classification frequencies for a particular land base and product performance by environmental classification, performance measurements are given the appropriate amount of relevance or weight for the land base in question. For example, the data are weighted based on long-term frequencies to compute a prediction of hybrid performance.

Use of G×E in Producer's Selection

[0077] According to another aspect of the present invention, a method of using information that documents the environmental profile over time of a crop producer's land base, the environmental performance profile of crop cultivars, and the producer's objectives to select a portfolio of cultivars that maximizes and quantifies the probability that the producer's objectives for productivity will be met. Environmental classification can be used to assist in this process.

[0078] Environmental classification can be used to determine the primary environmental drivers of G×E interaction in crops such as corn. That is, what are the primary environmental factors that cause change in the relative performance of hybrids. With this knowledge, crop production areas can be categorized into environmental frequency classes. Within these classes, hybrids tend to perform (as measured by yield) relatively similar to one another. Across these classes, the relative performance of hybrids tends to be significantly different. Using historical meteorological information along with soils, pests, and other agronomic information, the frequency of these environments can be determined. This allows the creation of an environmental profile for all or any part of the geography classified. That is, a frequency distribution of the occurrence of the key Environment Classes. This can be done for each crop producer's land base.

[0079] Similarly, the environmental performance profile of crop cultivars can be determined through field experimentation. That is, a description of relative performance of cultivars can be determined in each of the key environment classes. In combining Environment class frequencies for a particular land area and product performance by Environment Class, performance measurements are given an appropriate amount of relevance or weight for the land area in question

[0080] Thus, this aspect of the invention involves combining of this information at the producer's level to optimize crop productivity in such a way that it maximizes the probability of the producer's business operation reaching its productivity goals. The present invention contemplates that information can be used from any number of classification schemes to the selection of cultivars with the objective of maximizing the probability of attainment of the productivity and business goals of a crop producer's operation.

[0081] The approach of this aspect of the present invention does so by using compiled long term geo-referenced weather, soils, and agronomic data including biotic factors for the producer's land base to categorize the land base in terms of how frequently annual environmental variation occurs to a degree that is likely to impact relative hybrid performance. In addition, it can incorporate the producer's business objectives including, but not limited to preparedness to take risk. The present invention is able to combine environmental variability with producer business information to create a producer profile. Product performance information stratified by the same criteria is used to define the producer's environmental profile (for example, environmental classes) which is then integrated with the producer's profile.

[0082] The relative hybrid performance information that is relevant to the producer's land base is used regardless of when and where it was generated. The present inventors are first to predict future performance of genotypes and quantify probability/risk associated with that performance using data from environments that are considered to be substantially equivalent in terms of relative hybrid response. The result is a more robust and predictive data set thus allowing more informed product selection decisions that, over time will result in a higher probability of a producer operation meeting business objectives for productivity.

[0083] **FIG. 8** illustrates information flow according to one embodiment of the present invention. In **FIG. 8** there is an environmental profile **100**. The environmental profile can be based on one or more inputs such as environment classes **102**, meteorological information **104**, agronomic information **106**, or field experimentation **108**. In **FIG. 1** there is also a producer profile **110**. The producer profile **110** is based on one or more inputs such as risk tolerance **112** of the producer, business goals **114** of the producer, productivity goals **116**, financing **118** considerations, third party needs **119**, for example a landlord, or insurance/risk management and marketing **120** considerations. The environmental profile **100** and the producer profile **110** are combined in order to produce recommendations **122**. The recommendations **122** can include risk management tools, a recommended seed product, a recommended mix of seed products, production practice recommendations, such as chemical application information, or any number of other specific recommendations as may be appropriate based on the particular environmental profile **100** and producer profile **110**.

[0084] **FIG. 9** illustrates one embodiment of a system **124** for producing product recommendations. In **FIG. 9**, a processor **126** accesses information associated with a producer profile **110**, an environmental profile **100**, and a genotype by environment database **132**. There is an input device **128**, a recommendation output **129**, and a display **130** operatively connected to the processor. The present invention contemplates that the processor **126** can be associated with a computer such as handheld computer as may be convenient for a dealer or sales agent. The present invention also contemplates that the producer profile **110**, environmental profile **100**, and genotype by environment database **132** may be accessible over a network, including a wide-area network such as the Internet.

[**0085**] Using the information in the producer profile **110**, environmental profile **100**, and genotype-by-environment database **132**, the processor applies one or more of a product selection algorithm module **134**, a product comparator **136**, a production practice module and a risk comparator **138**, and a product portfolio module **140**. These and/or other modules are collectively the recommendation logic **142**. In a simple case, the product selection algorithm module **134** would take information from the environmental profile **100**, such as an environmental classification ("Temperate", for example) in addition to information from the producer profile **110**, such as a producer objective ("Maximize Yield", "Risk Minimization", "Low Harvest Moisture" for example) and match these criteria to products in the genotype-by-environment database **132**. Of course, more specific criteria could be examined as would be the case with more complex environmental profile information and more complex producer profile information.

[**0086**] **FIG. 10** illustrates one embodiment of a screen display **144** of a software application the present invention. In **FIG. 10**, a user is given the choice of selecting "DEFINE ENVIRONMENTAL PROFILE"**146**, "DEFINE PRODUCER PROFILE"**148**, and "VIEW RECOMMENDATIONS"**150**. Of course, the present invention contemplates that software and its accompanying user interface can be implemented in any number of ways.

[**0087**] **FIG. 11** illustrates one embodiment of a screen display **152** of a software application of the present invention. In **FIG. 11**, a recommendation is given which includes a plurality of products **154**, an associated number of acres **156** associated with each of the products, a risk/probability assessment **157**, and a recommended crop revenue assurance **158**. The present invention provides for decreasing the amount of risk associated with selection of a particular seed product by instead selecting multiple products with different G×E interactions in order to reduce risk associated with environmental variations. The resulting selection, is somewhat akin to selection of stocks in a stock portfolio.

[**0088**] **FIG. 12** and **FIG. 13** illustrate embodiments of user interfaces to use in precision farming applications. In **FIG. 12**, the user interface **170** includes site-specific information associated with location information **172**. The present invention contemplates that other site-specific information or historical information is accessible based on the location information **172** and may be used in product selections. In addition, environment and production information is collected. Examples of such information includes maturity days **176**, input traits **178**, output traits **180**, seed treatment **182**, whether no till practices **174** are used, the planting population **184**, nitrogen utilization **186**, and drought impact based on environmental classification drought frequency information **187** and soil type. Based on this information and information associated with the location **172**, a recommendation **188** of at least one hybrid seed product is made. Where multiple recommendations are made, the recommendations can be ranked as well as a risk assessment **189** such as shown.

[**0089**] **FIG. 13** illustrates another embodiment of a user interface **200** that can be used in crop production applications. Site specific information is collected such as location **172**, soil type **174**, and number of acres **202**. In addition, there is the option to import precision farming data **204** as well as import environment of frequency data **205**. There are also the options to set production practices, set environmental assumptions, set risk levels, and set the maximum number of hybrids **212**. Based on the inputs, a portfolio is created that includes a plurality of products **214**, an associated number of acres **216** to plant for each product, a recommendation **217** of at least one hybrid seed product, a risk assessment **218**, and revenue assurance **219**. Where multiple recommendations are made, the recommendations can be ranked. There is also an option to generate precision farming information **220** based on this information, such as a prescription map. The present invention contemplates that the precision farming information may indicate which acres to plant with which hybrids, give specific production practice application (such as chemical application rates), or other recommendations.

[**0090**] **FIG. 14** illustrates one example of a field-by-field analysis showing product recommendations for a land base of a producer. As shown in **FIG. 14**, different land areas within a producer's land base have different hybrids associated with them. The present invention contemplates producing such a map or field-by-field recommendations where multiple products are recommended. It should further be understood that a single producer or other user may have operations in a number of geographically diverse locations, and not necessarily the nearby fields illustrated in **FIG. 14**.

[**0091**] It should also be appreciated that the use of environmental classification and G×E interactions should be effectively communicated to customers. The effectiveness of the environmental classification process is based in part on its ability to use historical data from many locations so that all available data is used. This aspect of environmental classification would seem counter-intuitive to a customer who primarily relies upon personal knowledge in the local area. The customer's confidence in firsthand production knowledge can be used to assist in increasing confidence in environmental classification.

[**0092**] **FIG. 15** illustrates one example of the methodology of this aspect of the invention to assist in explaining these concepts to a producer. In step **300** site-specific data collection for a land base is performed. Based on this site-specific data collection, in step **302**, the land base is given an environmental classification. In addition to this information, the type of hybrid selected in the previous year and its performance is provided by the producer in step **304**. In step **306**, a prediction is made as to the previous year's production based on environmental classification. In step **308**, the predicted results are compared with the actual results. The present invention also contemplates not requiring performance results from the producer until after the previous year's results have been predicted in case the producer is not confident that an independent prediction is made.

[0093] **FIG. 16** illustrates one example of a screen display showing such comparisons. In **FIG. 16**, performance predictions (yield) are made for a number of different hybrids for both the previous year and the current year. In addition, a risk assessment for each hybrid may also be provided. The producer can compare the prediction for the previous year with the actual performance for that year in order to understand how well the environmental classification method can predict a result. If the producer is confident in the method's ability to correctly predict a result, the producer will be more inclined to use the prediction made for the coming year. The present invention contemplates that the same or similar information can be presented in any number of ways. It should further be understood that such a demonstrate assists in illustrating the accuracy of the system in predicting relative performance differences between seed products. Due to the number of potential variables and difficulty in controlling such variable accurate prediction of absolute performance is generally not a reasonable goal. However by selecting appropriate environmental classifications, useful insight into relative performance can be provided.

Compensation and Evaluating the Land Base

[0094] The present invention recognizes that agricultural input suppliers benefit from the success which they assist crop producers in obtaining. For example, when a seed product performs exceptionally well for a producer, such a seed product may be perceived as being of higher quality than competing products in future years. When a seed product performs poorly, such as seed product may be perceived as being of a lower quality or undesirable and the producer and other producers may be disinclined to purchase the seed product in future years. It should be appreciated that these perceptions are not facts, but merely one data point. While the genotype for each of the products may be capable of producing high performers, the circumstances regarding the environment, and the resulting G×E interactions may have limited performance. Therefore, the result of the performance has very limited utility when viewed in isolation because the same or highly similar environmental conditions may not be present in the future years. The use of the environmental classification system of the present invention is advantageous as it incorporates significant data and therefore does not limit one to an isolated and restrictive view of the performance of an agricultural input.

[0095] As previously indicated, there may be some resistance to use of an environmental classification system by particular producers because it requires reliance on data that was not observed firsthand. Also, as previously indicated there is a benefit to suppliers of agricultural inputs to have producers provide the best results. To increase the likelihood of those results the present invention, as an example, provides for tying the compensation received for the seed product to evaluating the land base on which the seed is to be planted and/or the performance of the seed product on the land base. One way of evaluating the land base is by promoting the use of environmental classification or other systems that take into account G×E interactions.

[0096] The compensation received for the seed products can be determined in a variety of different ways and can be of many different types. This can include, without limitation, pricing the seed product based on the performance of the seed product in the land base, determining the compensation received based at least partially on the quality of the land base, providing the at least one seed products in exchange for the compensation under a license agreement, and/or tying the use of the at least one seed product within the land base to a cost of use of the at least one seed product.

[0097] **FIG. 18** illustrates one embodiment of the present invention where an agricultural input supplier **500** provides a seed product **502** to a producer **504** in exchange for compensation under a license agreement **506**. The license agreement **506** includes an evaluation of the land base **514** based on an environmental classification **508** of the land base **514**, a determination of the location **510** of the land base **514**, the seed product **502** to be used at the land base **514**, and the price **512** of the seed product **502**. As a means of auditing the performance of the seed product **502** at the land base **514**, verification means **516** are employed. These may include remote sensing of the field, GPS data associated with crop production, weigh tickets, and yield monitoring data. Note that the verification can be of various types, including verifying that the proper type and amount of seed is planted at the agreed upon location as well as verifying the performance of the seed product.

[0098] Based on several factors, including but not limited to the environmental classification and performance of the genotype of each of the at least one seed product in the environmental profile of the land base, a recommendation for a producer regarding which seed products to use in the land base can be made. The producer accepting the recommendation and making purchases based on the recommendation may be a condition of receiving the seed product in exchange for compensation which is tied to the evaluation of the land base. The recommendation may include the selection of one or more specific products, or may include a recommendation that one or more products be selected from a particular set of products. Such a methodology encourages the producer in making decisions based on G×E interactions and/or environmental classification.

[0099] By tying the compensation received for seed products based on an evaluation of the land base and/or the performance of the seed products, the agricultural input supplier is picking up some of the risk of agricultural production. Alternating their role may be expressed as participating in value creation. One way the agricultural input supplier can add to the value is by making specific recommendations of inputs or practices which will or likely will enhance the value or performance of the crop. By making good recommendations, the agricultural supplier reduces their risks.

[0100] The agricultural input supplier can further offset the additional risk by taking positions in the grain market. In one embodiment of the invention, this may include purchasing options in order to cover any potential losses as a result of tying the compensation received for the seed products to evaluating the land base and/or the performance of the seed products on the land base. In other words, the agricultural supplier risks loss of income if its customers' crops perform poorly. When the customers' crops perform poorly if there is poor performance generally, then there is a greater likelihood that the price of crops will rise. Thus, the input supplier can manage risks by taking appropriate market positions. The agricultural input supplier can further manage risks by tying performance to price in diverse geographical locations and over a range of agricultural inputs to further diversify.

[0101] An additional way for the agricultural input supplier to offset risk is to require the producer to make a minimum payment for the seed. The agricultural input supplier might also require the use of risk management instruments, such as crop insurance or crop revenue insurance based on environmental classification of the land base and the recommendations and risk assessments for seed products, herbicides, insecticides, and other inputs or production practices. Of course, the present invention contemplates combining this information with other information that may be used in determining the compensation to be received in exchange for the seed products. The input supplier may require insurance, such as multi-peril or catastrophic coverage, to ensure the producer would be able to make the minimum payment for the seed. Crop revenue coverage may also be required to protect against lost revenue caused by low prices, low yields or any combination of the two.

[0102] Another type of risk confronting an input supplier is if a producer does not comply with the terms of the agreement. For example, a producer may try to buy seed for one location but plant it at another location. A producer may try to over buy seed for a location where the purchase price is less and plant some of the seed elsewhere. A producer may under-report past or actual performance. Thus, the input supplier needs to manage the risk associated with these and other scenarios.

[0103] In order to minimize this risk, the present invention provides for means for verifying the performance of the seed product in the land base. The verification may include the use of GPS data associated with planting and/or harvesting the seed products at the land base, reviewing weigh tickets and/or yield monitoring data for crops produced from the land base, and/or remote sensing of the land base. The GPS data can be used to verify that planting operations occurred at a particular location and other planting details that assist in verifying this information. Of course, in addition to or instead of analyzing this data, field service agronomists and/or crop scouts can also verify information.

[0104] **FIG. 19** provides an example of auditing the performance of a seed product. In **FIG. 19**, a license is formed which includes a determination of the location of the land base **550**, a classification of the land base **552** and a recommendation of seed products for use on the land base **554**. The present invention provides for using environmental classification and product recommendations in determining the licensing terms and conditions. The performance of the seed product may be audited at the planting stage by reviewing GPS data associated with planting the seed product **556**. At the growing stage, the seed product may be audited by use of remote sensing **558**. At the harvest stage, reviewing GPS data associated with harvesting the seed products **560**, reviewing weigh tickets associated with crop production **562**, and/or reviewing yield monitoring data **564** may be used to audit the performance of the seed products at the land base.

[0105] The present invention contemplates numerous variations from the specific embodiments provided herein. These include variations in the environmental classifications, performance characteristics, software or hardware where used, the type of and other variations.

[0106] All publications, patents and patent applications mentioned in the specification are indicative of the level of those skilled in the art to which this invention pertains. All such publications, patents and patent applications are incorporated by reference herein for the purpose cited to the same extent as if each was specifically and individually indicated to be incorporated by reference herein.

What is claimed:

1. A method of selling seed products for planting by a crop producer comprising:

characterizing a land base at which the seed will be planted;

determining the seed to be planted at the land base

pricing the seed product based on performance of the seed product within the land base.

2. The method of claim 1 wherein the step of characterizing the land base comprises providing an environmental classification of the land base.

3. The method of claim 1 wherein the performance is expected performance.

4. The method of claim 3 wherein the expected performance is at least partially based on characteristics of the land base.

5. The method of claim 4 wherein the characteristics of the land base are based at least partially on an environmental classification associated with the land base.

6. The method of claim 1 wherein the step of determining the seed to be planted at the land base is at least partially based on performance of the seed product associated with an environmental classification.

7. The method of claim 1 wherein the performance is actual performance.

8. The method of claim 1 further comprising recommending at least one type of seed product for use in the land base.

9. The method of claim 8 where the step of recommending at least one type of seed product for use in the land base is at least partially based on genotype-by-environment interactions between the seed product and the land base.

10. The method of claim 9 wherein the genotype-by-environment interactions are determined at least partially based on performance data associated with the seed products.

11. The method of claim 9 wherein the genotype-by-environment interactions are determined at least partially based on environmental classifications associated with performance data of the seed products.

12. The method of claim 1 further comprising auditing the performance of the at least one seed product within the land base.

13. The method of claim 1 wherein the step of pricing the seed product based on performance of the seed product within the land base is performed by a computer in operative communication with a database of performance data associated with land bases.

14. A method of selling seed products to a producer wherein compensation for the seed products is tied to the quality of the land base of the producer, the method, comprising:

evaluating the land base of the producer to determine a quality of the land base; determining compensation for at least one seed product at least partially based on the quality of the land base; and

providing the at least one seed products to the producer in exchange for the compensation.

15. The method of claim 14 wherein the step of evaluating the land base comprises providing an environmental classification of the land base.

16. The method of claim 15 wherein the environmental classification is selected from a set of environmental classes, the set of environmental classes comprising a temperate class, a temperate dry class, a temperate humid class, a high latitude class, and a subtropical class.

17. The method of claim 15 wherein the environmental classification is selected from a set of environmental classes, the set of environmental classes comprising biotic classifications.

18. The method of claim 15 wherein the quality of the land base is associated with the environmental classification.

19. The method of claim 15 wherein the quality of the land base is associated with performance of the seed product associated with the environmental classification.

20. The method of claim 14 further comprising recommending at least one type of seed product for use in the land base.

21. The method of claim 20 further comprising selecting crop insurance based on the recommendation.

22. The method of claim 20 where the step of recommending at least one type of seed product for use in the land base is at least partially based on genotype-by-environment interactions between the at least one seed product and the land base.

23. The method of claim 22 wherein the genotype-by-environment interactions are determined at least partially based on performance data associated with the seed products.

24. The method of claim 23 wherein the genotype-by-environment interactions are determined by statistical methods.

25. The method of claim 22 where the genotype-by-environment interactions are determined by a qualitative method.

26. The method of claim 25 where the qualitative method is phenotype plasticity.

27. The method of claim 22 wherein the genotype-by-environment interactions are determined at least partially based on environmental classifications associated with performance data of the seed products.

28. The method of claim 27, wherein said performance data includes at least one item from the set consisting of yield, drought resistance, grain moisture, lodging, stand establishment, emergence, midsilk, test weight, protein, oil, and starch percentage, relative maturity, plant height, seed size, disease resistance genes, heading date, resistance to insects, brittle snap, stalk breakage, resistance to fungus, seed moisture, head shape, hullability, seedling vigor, beginning bloom date, maturity date, seed shatter, winter survival, fiber strength, and color grade.

29. The method of claim 14 wherein the step of determining compensation for at least one seed product is at least partially based on both the quality of the land base and the expected performance of the at least one seed product within the land base.

30. The method of claim 14 wherein the step of determining compensation for at least one seed product is at least partially based on both the quality of the land base and the actual performance of the at least one seed product within the land base.

31. The method of claim 14 further comprising auditing the performance of the at least one seed product within the land base.

32. The method of claim 31 wherein the step of auditing incudes auditing GPS data associated with crop production in the land base.

33. The method of claim 32 wherein the GPS data is associated with planting the at least one seed product in the land base.

34. The method of claim 32 wherein the GPS data is associated with harvesting the at least one seed product from the land base.

35. The method of claim 31 wherein the step of auditing includes reviewing weigh tickets for crops produced from the land base.

36. The method of claim 31 wherein the step of auditing includes reviewing yield monitoring data for crops produced from the land base.

37. The method of claim 31 wherein the step of auditing comprises remote sensing of the land base.

38. The method of claim 14 wherein the step of providing the at least one seed products in exchange for the compensation further comprises providing the at least one seed products in exchange for the compensation under a license agreement.

39. The method of claim 14 wherein the at least one seed product is a plurality of seeds.

40. The method of claims **14** wherein the step of determining compensation for at least one seed product at least partially based on the quality of the land base is performed by a computer in operative communication with a database of performance data associated with land bases.

41. A method for auditing performance of at least one seed product used in a land base in a predetermined location, comprising:

determining the location of the land base at which the at least one seed product will be used;

tying the use of the at least one seed product within the land base to a cost of use of the at least one seed product; and

verifying use of the at least one seed product within said land base.

42. The method of claim 41 further comprising verifying performance of the seed product within the field.

43. The method of claim 41 wherein the step of verifying incudes auditing GPS data associated with crop production in the land base.

44. The method of claim 43 wherein the GPS data is associated with planting the at least one seed product in the land base.

45. The method of claim 43 wherein the GPS data is associated with harvesting the at least one seed product from the land base.

46. The method of claim 41 wherein the step of verifying includes reviewing weigh tickets for crops produced from the land base.

47. The method of claim 41 wherein the step of verifying includes reviewing yield monitoring data for crops produced from the land base.

48. The method of claim 41 wherein the step of verifying comprises remote sensing of the land base.

49. The method of claim 41 further comprising providing an environmental classification of the land base.

50. The method of claim 49 wherein the cost of use of the at least one seed product is at least partially determined based on expected genotype-by-environment interactions between the environmental classification associated with the land base and the at least one seed product.

51. The method of claim 41 further comprising recommending at least one type of seed product for use in the land base.

52. The method of claim 41 further comprising providing the at least one seed product in exchange for compensation, wherein said compensation is the cost of use of the at least one seed product.

53. A method for auditing performance of at least one seed product used in land base in a predetermined location using GPS data associated with crop production in the land base, the method comprising:

determining the location of the land base at which the at least one seed product will be planted;

providing the at least one seed product to be used at the land base in exchange for a compensation;

tying the use of the at least one seed product within the land base to the compensation; and

verifying the use of the at least one seed product using GPS data associated with crop production in the land base.

54. The method of claim 53 wherein the GPS data is associated with planting the at least one seed product in the land base.

55. The method of claim 53 wherein the GPS data is associated with harvesting the at least one seed product from the land base.

56. The method of claim 53 further comprising verifying performance of the seed product within the field.

57. The method of claim 53 further comprising providing an environmental classification of the land base.

58. The method of claim 57 wherein the cost of use of the at least one seed product is at least partially determined based on expected genotype-by-environment interactions between the environmental classification associated with the land base and the at least one seed product.

59. The method of claim 53 further comprising recommending at least one type of seed product for use in the land base.

60. A method of licensing at least one seed product for planting by a crop producer associated with a land base comprising a plurality of fields, the method comprising:

determining the at least one seed product to be planted in each of the plurality of fields of the land base;

providing an environmental classification of each field within the land base; and

determining a cost of the at least one seed product for each field within the land base at least partially based on the classification of each field within the land base.

61. The method of claim 60 further comprising recommending at least one type of seed product for use in each of the plurality of fields of the land base.

62. The method of claim 61 where the step of recommending at least one type of seed product for use in the land base is at least partially based on genotype-by-environment interactions between the at least one seed product and each of the plurality of fields of the land base.

63. The method of claim 62 wherein the genotype-by-environment interactions are determined at least partially based on performance data associated with the seed products.

64. The method of claim 62 wherein the genotype-by-environment interactions are determined at least partially based on environmental classifications associated with performance data of the seed products.

65. The method of claim 60 wherein the step of determining a cost of the at least one seed product is at least partially based on both the characterization of each of the plurality of fields within the land base and the expected performance of the at least one seed product within each of the plurality of fields within the land base.

66. The method of claim 60 wherein the step of determining a cost of the at least one seed product is at least partially based on both the characterization of each of the plurality of fields within the land base and the actual performance of the at least one seed product within each of the plurality of fields within the land base.

67. The method of claim 60 further comprising auditing the performance of the at least one seed product within each of the plurality of fields within the land base.

68. A method of recommending at least one seed product for planting by a crop producer associated with a land base comprising a plurality of fields, the method comprising:

identifying the location of the land base at which the at least one seed product will be planted;

classifying the land base to provide an environmental classification;

determining a recommendation of the at least one seed product to be used at the land base based on the environmental classification and performance of the genotype of each of the at least one seed product in the environmental profile of the land base;

determining compensation for the at least one seed product at least partially based on the quality of the land base; and

providing the at least one seed products to the producer in exchange for the compensation.

69. The method of claim 68 wherein the step of determining a cost of the at least one seed product is at least partially based on both the characterization of each of the plurality of fields within the land base and the expected performance of the at least one seed product within each of the plurality of fields within the land base.

70. The method of claim 68 wherein the step of determining a cost of the at least one seed product is at least partially based on both the characterization of each of the plurality of fields within the land base and the actual performance of the at least one seed product within each of the plurality of fields within the land base.

71. The method of claim 68 further comprising auditing the performance of the at least one seed product within each of the plurality of fields within the land base.

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