ALMANAC Advanced User Guide For More ALMANAC Capabilities

Congratulations! You already know how to run a basic ALMANAC simulation! This guide is for more in-depth, and atypical questions you wish to address using ALMANAC. Topics covered are:

Crop and Management

1. How to make a new CROP?
2. What are PHU and POP?
3. How to pick PHU and POP for competition or communities?
4. What is different when growing trees?
5. How to grow crops overwinter?
6. What do the TILL choices mean?
7. How to make a new TILL?
8. IRRIGATION
9. Automatic Fertilization
10. GRAZING

Weather

1. How to use future weather databases?
2. What are common US websites for weather source data?

Soil

1. How to change the number of soil layers?

Batch Runs

1. What is a batch run and when to use it?

Alternative Outputs

1. Where are the other outputs?
2. How to read the other outputs?

Alternative ALMANAC Codes

1. What are the other codes available?
2. What do they do differently?
3. How to run ALMANAC with an alternative code?

International simulations and ALMANAC

1. Yes! ALMANAC has been developed for Mexico!
2. How to run ALMANAC outside of the US, or ALMANAC Mexico outside of Mexico?
3. **How to make a new crop?**

There are two ways to make a new crop. The most user-friendly way is with the interface. Open an existing ALMANAC project. ALMANAC Inputs, Edit ALMANAC Databases, Crop. Be careful. Any edits done to the databases apply to all ALMANAC projects. The list of crops in your ALMANAC database is on the left. Select a crop similar to the one you wish to create. This highlighted crop will act as a template once you click Add. The original crop parameters are copied to the newly created crop. Name the crop, ok, give it a 4 character or less name, ok. Edit Crop and Save Edits just as in the typical ALMANAC menus. Likewise, hover over a value, or double click to see a definition of the value. Now the crop will be available in Management Schedules.

The second way to add crops is in the ALMANAC database directly. Close ALMANAC. Navigate to the folder ALMANAC is stored in, this is usually on the C drive. Open the ALMANAC folder, open the Databases folder, open ALMANAC2014.mdb This will open in Microsoft Access. Click the tblCrop. These are all the crops currently in your ALMANAC program. Again, be careful as the changes apply to all ALMANAC projects. Also note the crop number (CNUM) must be chronological. If you change the number of an existing crop, the associated management will no longer reference that crop until you change the management to reference the new number. After you make changes, save and close Access. Now you can open the ALMANAC program and use the crop.

1. **What are PHU and POP?**

These are found in the Management Schedule. PHU and POP are only entered when planting.

PHU is the potential heat units also known as summed growing degree days. Growth only occurs when the temperature is above the plant’s base temperature. The PHU is the sum of this for a number of days until the plant reaches maturity. For example, we would add all the days of the year after planting where (daily mean temperature) – (base temperature) was greater than 0 until harvest. Typically instead of calculating this, in ALMANAC we make an initial run with a very high PHU and see what the HU are at the maturity and/or harvest date. Then we adjust the PHU to that number and run the simulation again.

POP is the planting density in plants/m2. In the interface this is labeled as PLANTPO. For trees, this is plants/100m2. There are also two crop parameters involving plant population called PPL1 and PPL2. These are found in the crop database and will not typically be altered, unless you are creating a new species. The number before the decimal is the population, and the number after the decimal is the fraction of maximum LAI that can be reached at that density. PPL1 is for the lower density and PPL2 is for the higher density.

1. **How to pick PHU and POP for competition or communities?**

When growing multiple species it is important to find the right proportion of PHU and POP so the plants are in the density you expect. For example, in a prairie of switchgrass (*Panicum virgatum*) and buffalograss (*Bouteloua dactyloides*), the switchgrass is a much larger plant and therefore would have fewer POP than buffalograss. PHU may not be different between the species if they are reaching PHU by the end of the growing season. In some cases POP and PHU need to be adjusted when calibrating a community so they are in correct proportion to the field measurements, then the model can be validated and used for experimental questions.

1. **What is different when growing trees?**

When creating a new tree species in the crop database, all the typical crop parameters can be used along with a few specifically used to accommodate trees. TREE1 and TREE2 (or COSD and PRY as they are shown in the interface) are a multi-year s-curve function where the number before the decimal is the percent of the years to maturity. The numbers after the decimal are fraction of maximum potential LAI and height increase. CLAIYR is the number of years until maximum leaf area index can be reached. DMPHT minimum gras of biomass per meter of height. CHTYR is the number of years to maximum height. RTPRT1 is the fraction of weight partitioned to roots for young plants and RTPRT2 for plants near maturity. In the Management Schedule PLANTPOP is plants/100M2. In some instances, trees have different growth patterns based on age and separate sets of parameters are needed to model those differences. For an example, see this paper referenced below.

Kim, Su Min, Jaehak Jeong, Dan Keesee, and James R. Kiniry. "Development, growth, and biomass simulations of two common wetland tree species in Texas." *Environmental monitoring and assessment* 190 (2018): 1-16.

1. **How to grow crops overwinter?**

There are instances when the crop was planted the fall and should be harvested early in the next calendar year. The crop is then replanted in fall of the second year. ALMANAC may have trouble deciding which version of the crop to plant and harvest. How do you know if there is a problem? If the output is showing not enough LAI, YLD, or not planting during the rotation. Or 2 of the yearly crop tables are listed for the same year with too similar values, example, both have spring growth and none in the rest of year. Use this technique to achieve proper management. Create a new crop that is a duplicate of the original but with a different name to help distinguish the two. Amend the management to:

YR1 fall plant A
YR2 spring harvest A
fall plant B
YR3 next spring harvest B
next fall plant A, etc.

Alternatively, you could do 2 different runs starting on different years (scenarios work well for this) with:

YR1 fall plant A
YR2 next spring harvest A, fall no plant
YR3 spring no harvest, fall year 3 plant A
YR4 spring year 4 harvest A.

Both methods require an extra processing step after you have the output to determine the true average yield. Typically, these overwinter techniques are not needed for growing crops overwinter but are good troubleshooting methods if issues arise.

1. **What do the TILL choices mean?**

There are 9 types of tillage operations: Apply pesticides, Plant with drill, Plant in rows, Fertilizer operation, Irrigation operation, Harvests without killing the crop, Harvests and kills the crop, Builds furrow dikes, Destroys furrow dikes. There are 11 other parameters to determine how the operation is executed. To see details go to ALMANAC Inputs, Edit ALMANAC Databases, Till, and select the operation to see what parameters are being used. For example, HARHAY85, HARHAY90, HARHAY99 are harvest without killing the crop operations. The only difference between them is how much aboveground biomass is being removed from the field, 85%, 90%, or 99%. These functions are typically used for harvesting perennial grasses.

1. **How to make a new TILL?**

ALMANAC Inputs, Edit ALMANAC Databases, Till. Be careful. Any edits done to the databases apply to all ALMANAC projects. The list of tillage operations in your ALMANAC database is on the left. Select a tillage operation similar to the one you wish to create. This highlighted tillage will act as a template once you click Add. The original till parameters are copied to the newly created till. Name the operation, ok. Edit Tillage and Save Edits just as in the typical ALMANAC menus. Likewise, hover over a value, or double click to see a definition of the value. Now the operation will be available in Management Schedules.

1. **IRRIGATION**

There are two modes for irrigation, manual and automatic, and two types of irrigation, sprinkler and furrow. Both are accessed in the management schedule. To select sprinkler or furrow irrigation there is a section in the top right of the window called General Management Settings. IRR is set to 1 for sprinkler, and 2 for furrow.

Several other inputs can be adjusted related to water application and retention. EFI is the fraction of each irrigation application that is lost to runoff. To use a furrow dike system set IFD to 1. FDSF is the fraction of the furrow dike volume available for water storage. Furrow dike heights and intervals can be specified with an added tillage management operation. To use a drainage system, use IDR to install it in the desired soil layer. DRT is the time required for the drainage system to end plant aeration stress days.

For manual irrigation, Add Operation, select Irrigation Operation, IRRIGATE, OK. Enter the month and day irrigation is to occur. VIRR is the irrigation volume in mm to apply on that date. Now set the IRR in the General Management Settings box for the type of irrigation to apply. At a minimum only the IRR needs to be selected from this box, along with the management operation added for irrigation to run the simulation. There is also an option to apply the minimum volume needed to fill the soil to field capacity by setting the IRI in the General Management Settings box to 2 instead of specifying VIRR at the specific dates in the management operation.

For automatic irrigation, no operations need to be added, only make changes in the General Management Settings box. At a minimum only IRR, and BIR need to be selected for the simulation to run. BIR is the water stress factor to trigger automatic irrigation. To apply the minimum volume needed to fill the soil to field capacity, set the IRI to 2. Use ARMN to set a minimum, or ARMX to set a maximum volume for single irrigation application. Use VIMX to set a yearly maximum irrigation volume.

1. **Automatic Fertilization**

To apply automatic fertilization use the remainder of the parameters found in the management schedule’s top right corner of the window called General Management Settings. BFT is the N stress factor to trigger automatic fertilization. Other parameters available to specify amounts of fertilizer are IFA, LM, FNP, FNX. IFA is the minimum fertilizer application interval if not user defined in the management schedule. LM is to apply lime. FNP is the fraction of fertilizer potentially applied at planting. FNX is the maximum annual fertilizer applied.

1. **GRAZING**

ALMANAC comes with two different grazing management intensities, GRAZE1 and GRAZE2. Users can also create their own specifications for grazing intensity by creating a new TILL in the ALMANAC Database (see answer 7). ALMANAC does not differentiate between types of grazers or palatability. To account for these variations adjust the amount of animals grazing, the intensity of the graze operation, or the plant species grazed.

GRAZE1 is a lighter grazing intensity operation than GRAZE2. Animals will graze the top of the plant until 20cm remain for GRAZE1 (TLD = -200) and 10cm for GRAZE2 (TLD = -100). Harvest efficiency for GRAZE1 is 10% (HE = 0.1) and GRAZE2 is 50% (HE = 0.5). For grazing, ORHI is used to say that “values greater than 1 are KG/HA of biomass removed per day by grazing. For example, one animal/month is about the equivalent to 10 KG/Day”. GRAZE1 has ORHI set to 10 (one AUM per animal) and GRAZE2 has this at 0, so GRAZE1 animals will graze everyday until the management says STOP\_GRZ, but GRAZE2 will only graze the single day listed in the management. GRAZE1 is a lower intensity longer time management option, while GRAZE2 is high intensity short time management.

After deciding on the height, and AUM animals will be grazing, go to the management. Plant the species intended for grazing, then Add Operation, Start Grazing, and choose the operation you prefer. Select the plant species you want grazed. Where PHU would have been when planting, is now called GZLM. This is the stocking rate in heads/hectare. For example, with GRAZE1 if GZLM is 5, 5 AUM will be grazed each day. To stop grazing, Add Operation, Stop Grazing, STOP\_GRZ, and select the plant species that was being grazed. In the PHU be sure to list how many animals you want to stop grazing. For our example, if we wanted the whole herd to stop, PHU = 5. It is simple to adjust stocking rate of livestock and which plant they are browsing with these features. For mixed animal species different graze operations can be made and selected in the management. For mixed plant species, each management operation specifies how many animals are grazing that species. For example cows and goats have different AUM, and prefer different plants, as such ALMANAC can be adjusted as preferred.

The last factor users can adjust is called GZLM in the Scenario Information tab. This is the grazing limit in t/ha. When plant material gets to this low number grazing is automatically stopped. If grazing is set to begin, but not enough material is there, no grazing will occur until plant material is above this minimum value. Once above the minimum, grazing will begin unless the simulation has reached the STOP\_GRZ.

1. **How to use future weather databases?**

Future climate scenarios have been available in ALMANAC since 2011, however not many users are aware of them. Details about these four options are found in the GEOALMANAC Release Notes, but these are not only for use with batch runs. Open the ALMANAC database (usually found C:\ALMANAC\Datatbase). Back up a copy of the current climate weather database (tblWPM1MO\_Default). Copy a future climate table, such as tblWPM1MO\_Future\_A2\_2050, to tblWPM1MO\_Default and save. ALMANAC will use this until you replace it with another version of the table.

For batch runs, you do not need to replace or rename the databases. In the .csv file indicate the weather database you prefer in the appropriate column.

1. **What are common US websites for weather source data?**

NOAA’s (National Oceanic and Atmospheric Administration) NCDC (National Climatic Data Center) https://www.ncdc.noaa.gov/cdo-web/

NASA’s (National Aeronautics and Space Administration) POWER (Prediction of Worldwide Energy Resource) https://power.larc.nasa.gov/data-access-viewer/

gridMET https://webapps.jornada.nmsu.edu/weather/ https://www.climatologylab.org/gridmet.html

1. **How to change the number of soil layers?**

To adjust the number of soil layers close ALMANAC after setting your basic project up. No need to do a detailed management yet. Open the folder ALMANAC is stored in, this folder has all the folders from ALMANAC in it and is typically in the C drive. Open the ALMANAC Projects folder, and then the folder with your project’s name. Open the database found in this folder. This opens in Microsoft Access. Open the tblSOIL\_COMP table. Find the soil id from your simulations. Change the N Layer to the desired number of soil layers. Open the tblSOIL\_LAYER table. Find the soil from your simulation and add or remove a layer depending on your goal. Note SLID must be in numerical order and it is ok to skip numbers. Save tables and the database. Now close the database and open your ALMANAC program and the project you have created. Scenario Definitions Soil tab will now display the number of layers designated in the database.

Batch run soil change instructions are found in GEOALMANAC Release Notes. The batch must be run with the original soil file path (SSURGO\_Path) before changing the soil, then edit the soil and .csv as described, and rerun the batch.

1. **What is a batch run and when to use it?**

When a user needs to make more than one ALMANAC run there are three options. 1. Creating a new ALMANAC project is the most time consuming to navigate between projects to edit, run, and see results. This may be required if a different location is simulated and you don’t use option 3 below. 2. In a standard ALMANAC project, a different scenario is created in the same location but may have a different time frame, soil, management etc. and is run one simulation at a time. This is the most efficient and simple way when many edits are needed and only a small number of simulations are done. 3. A batch run is a way to create and run many different ALMANAC simulations at once. This is useful when the user would have been creating multiple projects, or when copious scenarios are needed. Examples may include different geographical locations, managements, weather conditions, etc. The instructions for how to create a batch run come with the ALMANAC program. Navigate to your ALMANAC folder (usually found on the C drive), open the help folder, and the document GEOALMANAC Release Notes. For an example of batch run application, the first publication that used this feature did so across the entire eastern US and is referenced below.

Behrman, Kathrine D., James R. Kiniry, Michael Winchell, Thomas E. Juenger, and Timothy H. Keitt. "Spatial forecasting of switchgrass productivity under current and future climate change scenarios." *Ecological Applications* 23, no. 1 (2013): 73-85.

1. **Where are the other outputs?**

Besides just opening the output in the interface, ALMANAC creates several additional outputs. Open the ALMANAC folder, ALMANAC\_Projects, the folder of the project, Scenarios, and the scenario that was run. Here you see 9 additional .out files besides the ALNC\_Run.out that you can access in the ALMANAC interface.

If a batch run was completed the output is stored in the folder you designated, and details about those outputs are found in the GEOALMANAC Release Notes.

1. **How to read the other outputs?**

All of the outputs begin with ALNC\_, for ALMANAC. The following two letters designate how often the output is reporting the results. AN is for annual, MO is monthly, and DL is daily. The DL outputs may be blank, unless you have selected to run a daily output in the interface Scenario Definition (NIPD=0, IPD=6). The final letter describes what type of data is included in the output. C is for crop, H is hydrology, and W is weather. The columns correspond with ALMANAC abbreviations, for example, BIOM is total biomass. These outputs do not have a label for crop name or ID, so when running multiple species check the original ALNC\_Run.out to determine which row is which species. These other outputs are useful to quickly and easily transfer data for data analysis, and to determine how the simulation responded to user inputs.

1. **What are the other codes available?**

The ALMANAC website lists several alternative codes. New Code for Weather (4/29/2016), Desert Woody 3 (5/27/2016), and Tall Fescue with Summer Dormancy (12/14/2016).

1. **What do they do differently?**

New Code for Weather: This is the same as the online code but allows for triggering the weather generator in slightly different formats. ALMANAC typically uses 999 to trigger use of the weather generator for a specific weather input on a specific day. This New Code for Weather allows the user to have 999 or -999 in place to trigger the weather generator. The user can also use values >990 and <-990.

Desert Woody 3: This code builds on ‘New Code for Weather’ and was created to account for plants grown in severe drought. In severe drought no heat units (HU) would accumulate, LAI may be reduced, and the drought may kill plants. This code was used to simulate creosote (an evergreen desert shrub), and honey mesquite (a southwestern deciduous tree) in the following paper.

Kim, Sumin, Jaehak Jeong, and James R. Kiniry. "Simulating the productivity of desert woody shrubs in southwestern Texas." In *Arid Environments and Sustainability*, pp. 23-52. IntechOpen, 2018.

Tall Fescue with Summer Dormancy: This is code for bimodal growth curves. In the code, THRL is the threshold for dormancy of cool season perennial grass where it will become dormant in the summer. Select IDC 9 in the plant parameters for bimodal growth when using this code. This code was used to simulate Tall Fescue (a cool season perennial grass) with bimodal growth in the following paper.

Kiniry, J. R., S. Kim, A. S. Williams, T. R. Lock, and R. L. Kallenbach. "Simulating bimodal tall fescue growth with a degree‐day‐based process‐oriented plant model." *Grass and forage science* 73, no. 2 (2018): 432-439.

1. **How to run ALMANAC with an alternative code?**

To use an alternative ALMANAC code, place the .exe in your ALMANAC folder. This is typically found in the C drive and contains all the ALMANAC files. The .exe that comes with the program is called alnc2014.exe Rename this file something to recognize it as the original. Now rename the alternative code as alnc2014.exe (the name is not case sensitive). Open the ALMANAC program and now the alternative code is being used. To change back to the original code or to any other code, just rename the files again.

1. **Yes! ALMANAC has been developed for Mexico!**

ALMANAC Mexico is available in both English and Spanish. To download the model, the manual, and the reference, please see the website: https://www.ars.usda.gov/plains-area/temple-tx/grassland-soil-and-water-research-laboratory/docs/almanacmex/

1. **How to run ALMANAC outside of the US, or ALMANAC Mexico outside of Mexico?**

For International Sites not in the USA or Mexico:

The more soil and weather information from the site of origin the better the simulation. The most important soil characteristics are depth, and rock/sand/silt/clay proportions. Real weather is strongly preferred as the original site may have very different seasons, solar radiation, wind, etc. If no local weather station is available, there are websites with satellite data such as this one from NASA: https://power.larc.nasa.gov/data-access-viewer/

Set up the ALMANAC or ALMANAC Mexico project. Choose a place in the program’s country that has a similar climate and soil type. The origin country will probably be in a different hemisphere, so be sure to account for this so the coordinates match those of the program’s country. Coordinates, or location picked from the map, must be within the county selected for ALMANAC or ALMANAC Mexico to run. If using ALMANAC Mexico, no need to download soils as they come with that program. If using ALMANAC, download the SSURGO soil for the similar US site you chose. Once the soil is selected in ALMANAC or ALMANAC Mexico, that will act as a template to be adjusted to the soil values specific to the origin country. This helps fill in any gaps with the best guess for where the origin data is lacking. Select the weather file from the origin country. Make sure the file is in ALMANAC format. Note that any gaps in weather data will be filled with the weather generator from the program’s site, not weather from the origin country. Once the project is established, it is simple to augment the soils in the scenario definition soils tab. If you need to change the number of soil layers, see answer 12 above for instructions.

Example using ALMANAC (programed for the US) simulating Australia. First look at the origin soil and weather. This example has sandy loam soil, low humidity, high solar radiation, and 260mm annual rainfall. Similar US weather is found in the desert southwest. An internet search found a similar county with that weather. On the SSURGO web soil survey website create an AOI (area of interest) in that county. Look at the soil map tab and click on a few soil names. Soil with sandy loam and several matching characteristics were found. Remember the soil name and determine the latitude and longitude for that soil. It is not mandatory to use the exact coordinates from the SSURGO soil for a single simulation (you can pick location from the map and manually choose the intended soil), however, this is recommended because coordinates within the county are mandatory, as having the soil coordinates allows for the program to select the proper soil. The program will also reference the nearest weather station in the weather generator to the location. If this is part of a batch run it is much easier to use the soil coordinates for the .csv file as the soil and weather will be correctly selected the first time. Download the county’s soil from the download soils data tab. When creating the ALMANAC project use the state, county, and lat/long from the US soil, and select the SSURGO soil file and soil name. Input the weather file from Australia. Note that ALMANAC is in the Northern Hemisphere and Australia is in the Southern, therefore the seasons are opposite. If the origin weather did not come with temperature, the user would not want this to be generated from the Northern hemisphere as the seasons are inverse. Now in the scenario definition soil tab, adjust the US soil to match as much of Australia’s soil as possible. Set up the remaining management, scenario, and run ALMANAC.