Appendix C. Light Measurement Conversions

(updated October 2008)

There are a bewildering number of ways to measure light, and unfortunately, most of them seem to be in use simultaneously. It's not unusual to read four articles on greenhouse lighting and see four different references to light intensity from foot candles to lux, to watts, to lumens.

The multitude of ways of expressing the visible radiation received by plants has hindered our understanding of practical lighting needs and supplementing illumination. Lighting engineers prefer to use illumination units such as foot candles, lumens, lux, and klux since these measurements give a good indication of the illumination intensity to the human eye.

Since plants do not 'see' light the way humans do, some photobiologists prefer to use measurements of absolute energy such as watts per square metre. Others prefer quantum measurements of photosynthetically active radiation (PAR) which is in the 400-700 nanometer wavelength range and is expressed in units of microeinsteins or micromoles.

Climate control computer systems with attached light sensors usually measure light levels in Watts/m^2 (pyranometer sensors) or in microeinsteins per square metre per second (mEs^{-1}m^{-2}) (PAR sensors.)

Conversion of Light Units from Various Lighting Sources*						
	Light Source Conversion Factor					
Multiply by the Conversion Factor to Convert "from → to"	**Day Light**	**Metal Halide**	**High Pressure Sodium**	**Mercury Vapour**	**Cool White Flourescent**	**Incandescent**
Wm^{-2} (PAR) → µE s^{-1} m^{-2} (PAR)	4.6	4.6	5.0	4.7	4.6	5.0
Wm^{-2} (PAR) → Klux	0.25	0.32	0.36	0.33	0.37	0.25
Klux → µE s^{-1} m^{-2} (PAR)	18	14	14	14	12	20
Klux → Wm^{-2} (PAR)	4.0	3.1	2.8	3.0	2.7	4.0
Footcandles → µE s^{-1} m^{-2} (PAR)	0.20	0.15	0.15	0.15	0.13	0.22
µE s^{-1} m^{-2} (PAR) → Footcandles	5	6.7	6.7	6.7	7.8	4.5
* Light conversion from Li-Cor literature						

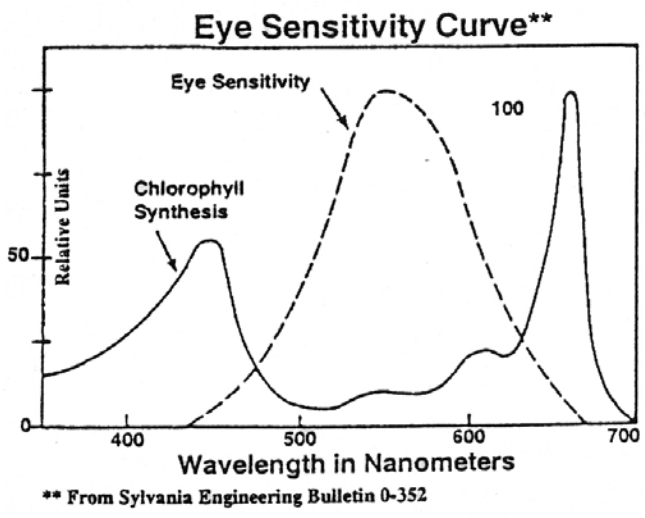
Some Lighting Definitions:

Visible Radiation: light energy in the visible portion of the spectrum having wavelengths from 400-700 nanometers (nm).

Illuminance: a measure of brightness per unit area. Illuminance units are foot-candles (fc), lumen (lu), and lux (lx) as measured by photometry.

High Intensity Discharge (HID) Lamps: refers to all mercury, metal halide, and sodium lamps which operate by exciting their various elements at high voltages.

Photosynthetically Active Radiation (PAR): radiation in the 400 - 700 nm waveband. PAR is commonly expressed in microeinsteins per square metre per second (mE $m^{-2}S^{-1}$) or in micromols per square metre per second ($m$mol $m^{-2}S^{-1}$) which are equivalent. The LI-COR quantom sensor (LI-190S) is generally used for this measurement.



Other Light Conversions:	
	Multiply by:
Klux to Lux	0.001
Lux to Klux	1,000
Klux to footcandles	92
Foot candles to Klux	0.011
Lux to lumens m^2	1
Lux to lumens ft^2	0.0920